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OCTOBER, 1934

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BOOST HOUSING CAMPAIGN WITH EXPOSITION

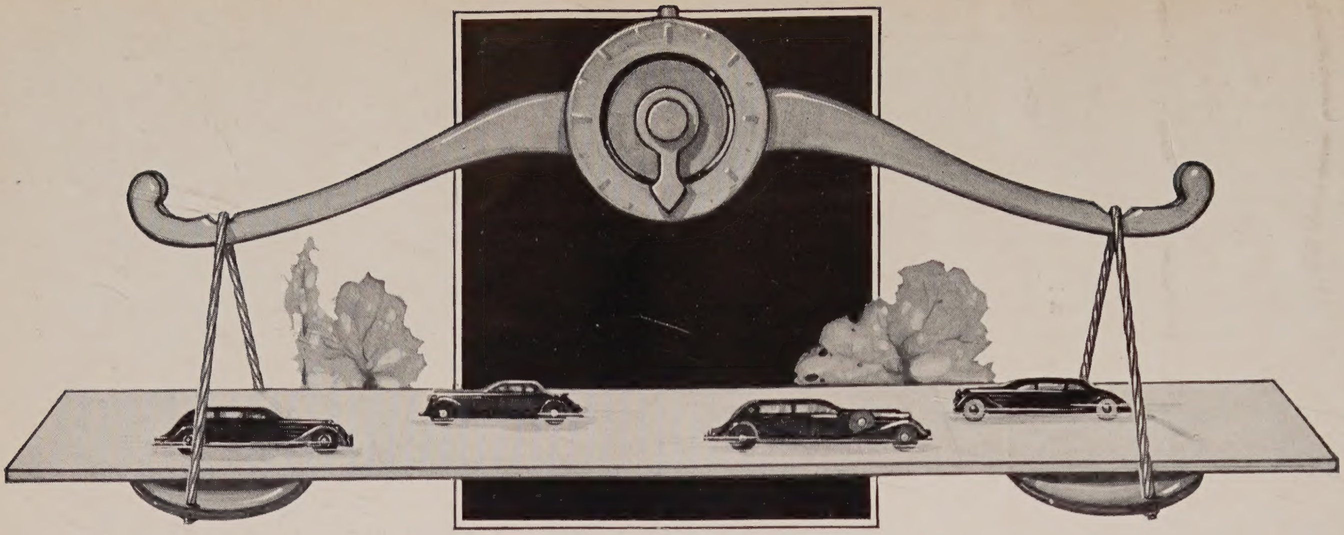
◆

A MODERN home exposition, sponsored by the city and endorsed by the St. Louis Chamber of Commerce, will be held in St. Louis' new Municipal Auditorium November 10 to 18, inclusive.

¶ St. Louis contractors, building supply dealers and architects, eager to share in the estimated expenditure of $15,000,000 for home modernization under the provisions of the National Housing Act, have already engaged one third of the new auditorium's exhibition space. Early indications point to a complete sell-out for the nine days of merchandising and selling in what has been called the nation's finest exhibition building.

¶ A better-housing program will be undertaken in connection with the exposition by the Chamber of Commerce, which will have 1,000 house-to-house canvassers to stimulate interest in home improvement. Broad publicity and radio campaigns have been launched to further the best interests of the exhibitors.

¶ Here is a forceful example of community action—an example that might well be followed by many other cities. A telegram to the St. Louis Chamber of Commerce will bring full information on the details of organization of the St. Louis campaign.



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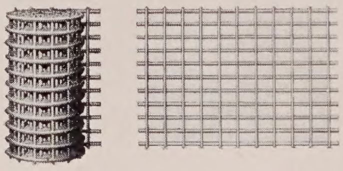
In a thickened edge pavement design, test data agree that all cracks that may form and all joints or planes of weakness must be shear resistant in order to provide a balanced design and an adequate Safety Factor. **American Steel & Wire Company Welded Wire Fabric** ties together all unpredetermined cracks that may form in a pavement in spite of **carefully** predetermined expansion and contraction joints. In this manner a balanced design and an adequate Safety Factor is maintained. All cracks as well as joints and planes of weakness remain shear resistant and failure of the concrete is prevented. Our booklet Reinforced Roads and Streets explains in detail the Design procedure for various types of concrete pavements. Your copy will be forwarded on request.

ELECTRIC WELDED WIRE FABRIC



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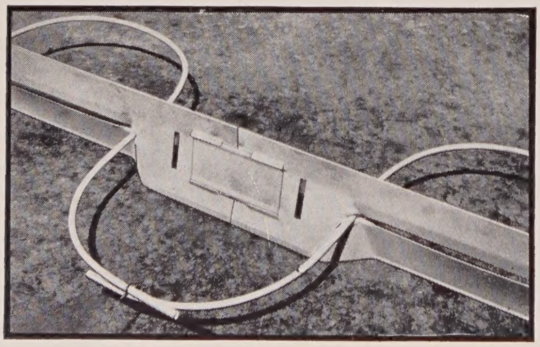

SMITH METAL LACED JOINT

FOR CONCRETE ROADS

This new longitudinal joint for concrete roads serves the purpose of separating the pavement in definite slabs or lanes, which, at the same time, are interlocked and laced together. We are national distributors for the Smith Metal Laced Joint and shall be glad to send you a descriptive bulletin upon request.

1831 MORE THAN 100 YEARS OF PROGRESS IN WIRE MAKING 1934

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VOL. XLII, NO. 10 — Concrete — OCTOBER, 1934

Chicago's New Sewage Treatment Works to Employ Modern Principles

Construction Resumed with PWA Money—Unusual Distributing Plant Places 60,000 Cu. Yd. of High-Quality Concrete —Much Mechanical Equipment Installed

TYPICAL of the many large sewage disposal plants now under construction with funds supplied by the federal Public Works Administration, known more popularly as the PWA, is the huge project in the southern part of Chicago, near East 126th Street and Cottage Grove Avenue. This sewage disposal project is known as the Calumet Sewage Treatment Works Extension of the Sanitary District of Chicago; and while it is, in fact, an extension of an existing sewage disposal plant, the magnitude of the new project is such that it overshadows completely the existing establishment.

Construction Resumed with PWA Money

Contracts for a considerable part of the work at present under construction were awarded in 1931, but lack of funds prevented completion of the work at that time. Not until PWA funds were made available early this year was it possible to resume construction on the 1931 contracts and to award additional contracts.

Public Interest in Sewage Disposal

Interest in the disposal of sewage is quite general throughout the country, not only among construction people, but among the more intelligent strata of the entire population. The sustained drought of the past few years has driven into the public mind a more complete realization of the folly of our nationwide practice of dumping untreated sewage into streams. The greatly reduced flow of the streams, because of the drought, has resulted in more intensive pollution, with the consequent wholesale destruction of fish and other aquatic life. Many of our most beautiful streams, in effect, have become open sewers.

Because of the existing situation and the growing sentiment in favor of a more intelligent solution of our sewage problems, it will be well to give the necessary space to a brief general description of the Calumet Sewage Treatment Works. While this is a huge project, the fact remains that sewage disposal plants for smaller cities provide for a similar method of treating sewage. The difference, after all, is largely a matter of size.

Plant Serves 88 Square Miles

The plant now under construction has been designed for the purpose of ultimately treating all of the sewage from the area lying between 87th Street in Chicago on the north, 159th Street on the south, South Crawford Avenue on the west and the Indiana state line on the east—about 88 square miles. The population of this area in 1945 is expected to be about 455,000, contributing an estimated average sewage flow of 136 m.g.d., for which the present installation is designed. Space has been left and provision has been made to increase the average capacity to 200 m.g.d. if required in the distant future. When the plant is placed in operation next year the average flow will be about 75 m.g.d. and the tributary population about 238,000. Additional sewage will be brought in, as interceptors are extended to outlying areas. All parts of the plant are designed to handle 50 per cent in excess of average flows.

Passing Through Aeration Tanks

Sewage coming to this plant will be lifted 39 ft. by pumps, passed through mechanically-cleaned rack screens with ⅝-in. clear openings, settled for a short time (10 minutes for 136 m.g.d.) in tanks with mechanical removal of settled solids, and then treated by the activated sludge process. This involves blowing air through a mixture of sewage and sludge for about five hours in aeration tanks. The sludge in the mixture has been previously activated by air. The sludge appears as a light brown flocculent mass in the tanks. It contains certain biological growths which are developed in the process. By aid of these growths and the air used for aeration, the finely divided or colloidal matter in the sewage is removed and the organic matter in solution is largely oxidized to stable or non-putrescible forms.

Final Settling Tanks

The aerated sewage is settled in the final settling tanks and the sludge drawn off from the bottom. Part of this sludge is then returned to the sewage continuously entering the aeration tanks in an amount equal approximately to 20 per cent of the sewage by volume. Clarified sewage discharges from the surface of the final settling tanks as a clear, stable effluent free from suspended solids. It will be discharged into the Calumet Sag Channel to the west of the controlling works in Blue Island.

The sludge not returned for use in the process, together with the preliminary tank sludge and screenings, will be concentrated in tanks and partially de-watered by vacuum filters. The organic solids in the filter cake will then be destroyed by incineration, leaving for disposal only an odorless and inert ash. The initial average incinerator capacity will be 40 tons of dry solids per day.

Much Mechanical Equipment Installed

The work now under construction is divided into seven divisions, comprising seven separate contracts. Four of the contracts cover mechanical equipment of various kinds. Three of these are the separate contracts for supplying (but not installing) four turbo-blower units, six centrifugal pumping units, and a number of large gate and check valves to be used on the sewage and air lines in the pumping station. These three contracts, designated respectively as Divisions *A*, *B* and *E*, totaled $232,929.

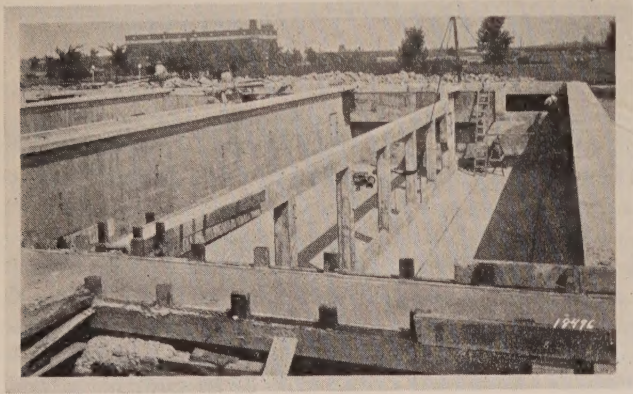


Figure 1. Preliminary settling tanks, where heavy solid matter such as stones, sand, grit and rags are removed. The existing sewage treatment plant is shown in the background

Another contract, designated as Division *G*, covers the extension of discharge tubes from the main sewage pumps to permit the location of the incinerator building adjacent to the pumping station.

Pumping Station and Blower Building

The remaining three contracts thus far awarded cover construction work—mainly concrete. The one designated as Division *C* includes the pumping station and blower building, and the principal facts concerning it are as follows:

PUMPING STATION AND BLOWER BUILDING

Value of contract, as awarded to John Griffiths & Sons Co., of Chicago $1,411,398
Building—116 ft. wide by 276 ft. long.
Substructure extends 32 ft. below present grade.
Superstructure approximately 40 ft. high.
Contract includes installation of equipment purchased under Divisions *A*, *B* and *E*, and furnishing and installation of all electrical and other mechanical equipment.
Space is left for one additional sewage pump, one sludge return pump, and one blower.
Approximate Quantities, Main Items:
44,000 cu. yd. excavation
11,500 cu. yd. concrete
1,000,000 lb. reinforcing steel
660,000 lb. structural steel

Preliminary Settling Tanks

The preliminary settling tanks, sludge concentration tanks, screen house, meter vault and miscellaneous conduits comprise Division *F*. The principal facts about this contract are as follows:

SCREEN HOUSE, PRELIMINARY SETTLING TANKS, SLUDGE CONCENTRATION TANKS, METER VAULT AND MISCELLANEOUS CONDUITS

Value of contract, as awarded to the Obermeier Construction Co., of Chicago $279,800
Screen House—84.5 ft. by 36 ft.,
Three mechanically cleaned rack screens.
Two screenings grinders
Preliminary Settling Tanks,
Four tanks, each 32 ft. wide, 100 ft. long and 12.5 ft. deep, with conveyor type sludge removal mechanisms.
Sludge Concentration Tanks,
Two tanks, each 17.2 ft. wide, 80 ft. long and 12.5 ft. deep, with conveyer type sludge removal mechanisms.
Approximate Quantities, Main Items:
14,500 cu. yd. excavation
5,500 cu. yd. concrete
900,000 lb. reinforcing, structural and miscellaneous steel
415,000 lb. cast iron pipe and fittings

Aeration and Final Settling Tanks

All the contracts thus far described were awarded in 1931; but as previously explained, lack of funds necessitated suspension of work until PWA funds were made available in the early months of 1934. However, the largest of all the present contracts was awarded in the spring of this year. This was the contract for the aeration tanks and the final settling tanks, awarded to the Herlihy Mid-Continent Co. at $2,182,796. Work on this part of the project, designated as Division *D*, was not started until May 16, 1934; but even though it involves the placing of 60,000 cu. yd. of concrete over an area of 12 acres, the work is now (September 19) approaching completion. During July and August concrete was placed at the rate of 550 cu. yd. daily. The principal facts about this part of the project are—

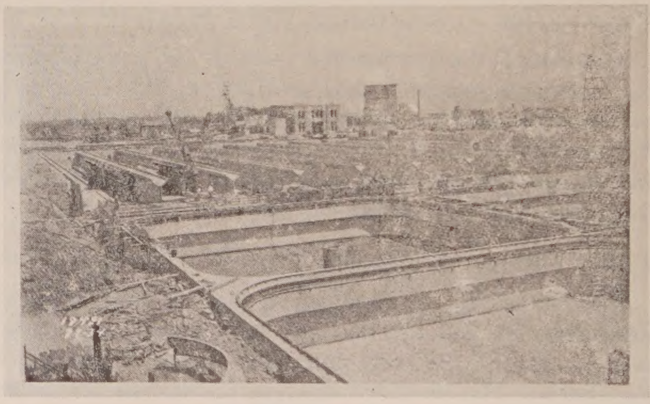


Figure 2. Final settling tanks in foreground, with series of aeration tanks in middle distance, and pumping station and blower building in background. Note the north tower of the concrete distributing system in the background, extreme right

AERATION AND FINAL SETTLING TANKS

Value of contract, as awarded to the Herlihy Mid-Continent Co., of Chicago $2,182,796
Two batteries of tanks, each battery consisting of eleven aeration tanks, each 425 ft. long, 34.5 ft. between walls and 17 ft. deep, and eight final settling tanks with revolving type sludge removal mechanisms, each 91 ft. square and 15 ft. deep.
Approximate Quantities, Main Items:
268,000 cu. yd. excavation
60,000 cu. yd. concrete
8,000,000 lb. reinforcing and miscellaneous steel
4,280,000 lb. cast iron pipe and fittings.

Concrete Mixing and Distributing Plant

The concrete mixing plant is laid out in line with the usual practice on large projects. Aggregates and bulk cement are received in freight cars in track hoppers. The aggregates are then elevated in bucket elevators to overhead storage bins, which discharge direct to the twin mixers.

The bulk cement is delivered in hopper-bottom railway cars, discharged into a horizontal screw conveyor placed immediately under the rails, this conveyor discharging into the boot of a housed-in vertical elevator which delivers the cement to an overhead storage bin. From this large storage bin the cement passes in a closed chute to an auxiliary bin which supplies the mixers.

The concrete distributing system is the outstanding feature of the Herlihy Mid-Continent contract. The two mixers, each of 1 cu. yd. capacity, discharge on two belt conveyors which transport the freshly mixed concrete to two elevated hoppers a short distance away. From these hoppers the concrete is discharged into huge concrete buckets of 7 cu. yd. capacity, supported and moved on railway flat-cars.

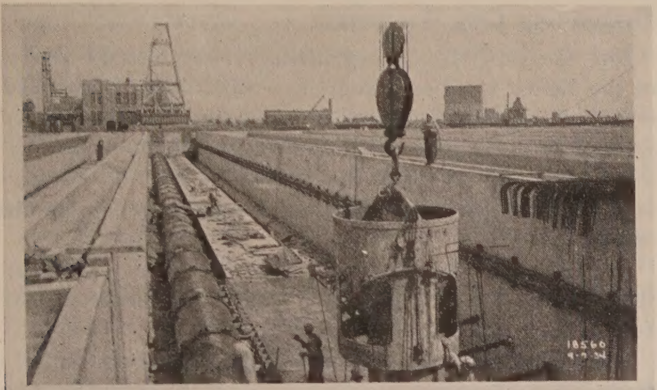


Figure 3. Aeration tanks, looking north, toward the north tower of the concrete distributing system. One of the 7-yard concrete distributing buckets is shown in the immediate foreground

Transport Concrete on Cables

The flat-cars are then drawn by cable to the south distributing tower, which moves back and forth on double tracks, keeping opposite the north tower shown in several of the illustrations. Between the towers a cable is suspended. When the flat-car carrying the concrete buckets reaches the south tower, the 7-yard buckets are lifted off and are transported to the desired point by a trolley moving on the cable. The buckets discharge their cargo of fresh concrete directly into the forms.

Metal forms, built up in sections and used repeatedly, were employed for most of the straight wall work, such as the walls of the aeration tanks. Some plywood also was used, notably in the forms for the final settling tanks.

Finished Concrete Has Excellent Appearance

The finished concrete presents an excellent appearance. The nominal proportions were specified as $1:2\frac{1}{4}:3\frac{3}{4}$, with aggregates consisting of torpedo sand and crushed stone. Some deviation from the nominal proportions was allowed, in order to obtain the greatest possible density; but the contractor was required to adhere to a minimum of $5\frac{1}{2}$ sacks of cement to the cubic yard of concrete.

To Utilize High-Frequency Vibration

It is the intention of the engineering department of the Sanitary District to make some changes in future specifications, so as to utilize the advantages of high-frequency vibration. The engineers feel that with their present knowledge of vibration, based on actual experience, they will be able to obtain concrete of a high degree of density while at the same time they can lower both the water-cement ratio and the cement content. They expect to get the cement content down to 5 sacks, or less, to the cubic yard of concrete.

Other Contracts Being Awarded

For the past several months, there has been an average of 625 men on the site directly engaged in the work involved under the above contracts.

On September 20, bids were opened for two more contracts. One includes the construction of an influent sewer from the old Calumet pumping station to the new one with connections for future sewers from the south, a by-pass for the new plant and an effluent by-pass around the old pumping station. The other contract is for the purchase of diffuser plates to be installed in the aeration tanks.

Late this year or in the early part of next, contracts will be let for the sludge disposal plant and for miscellaneous work required to complete the plant for operation.

Acknowledgments

Mention has previously been made of the contractors on the three construction projects comprising this work. The storage bins at the concrete mixing plant of the Herlihy Mid-Continent contract are of Blaw-Knox manufacture, while the conveying and elevating equipment are of Link-Belt manufacture. The Blaw-Knox company also supplied the huge 7-yard concrete distributing buckets, as well as the steel forms for the walls of the aeration tanks. Koehring concrete mixers are used. Plywood was supplied by the Harbor Plywood Corp.

This huge sewage treatment plant was designed in the engineering department of the Sanitary District of Chicago, under the immediate direction of L. C. Whittemore, Engineer of Design, and the general direction of Philip Harrington, Chief Engineer. Structural design work such as the pumping station and blower building was under the direction of Ralph R. Leffler, Engineer of Structural Design. The engineer in charge of construction is Lawrence B. Barker, Principal Construction Engineer.

Leipzig Fair Successful

THE Leipzig Trade Fair just concluded comprised 4,696 exhibits, an increase of seven per cent over the last fall Fair. It was attended by over 4,000 foreign buyers, an increase of ten per cent as compared with 1933, while the total number of visitors approached 100,000. A gratifying increase was observed in the exhibits of textiles, building materials, household furnishings, the arts crafts, and ceramics. The sales in all divisions are reported satisfactory, with a significant rise in foreign orders. This famous Fair is the great clearing house for extending German trade with foreign countries, and is now approaching its 1,500th session.

August Construction Is Higher

AUGUST construction contracts in the 37 states east of the Rocky Mountains amounted to $120,244,500, according to the Dodge reports. This is slightly higher than July, and 13 per cent higher than in August, 1933. The increase in both comparisons lies in non-residential construction of all classifications.

Construction and Industrial Groups Meet Federal Housing Officials

Financial Houses Also Represented at Huge Chicago Meeting —Nation-wide Remodeling Campaign Under Way—Start New Building Campaign in November

A MEETING attended by more than 1,000 men and women representing all branches of the construction industry, as well as many other industries, financial houses, and publishing and advertising interests, was held at the Palmer House, in Chicago, on September 18, for the purpose of getting factual information on the Better Housing Program launched by the Federal Housing Administration.

To Stimulate Every Industry

The principal address, both at the morning session and at the luncheon, was delivered by Ward M. Canaday, director of public relations for the Federal Housing Administration.

The importance of the construction industry, he pointed out, lies in the fact that its revival will stimulate not only the construction industry, but by putting the men in the building trades back to work every other industry will be benefitted.

In the United States, at the present time, there are about 200,000 manufacturing plants, in all lines of industry, and about 50,000 of these plants are in the construction trades. The vastness of the effect to be gained from the stimulation of the construction industry may, therefore, be realized.

Construction Revives England

Mr. Canaday declared that the revival of business in England is due mainly to the revival of construction, and residential construction was by far the most important factor in this activity. During 1934, he said, England is building 300,000 houses, while the United States, with a population of three times that of England, is building only 50,000. The program in England, furthermore, contemplates the construction of 1,000,000 houses in 1935.

In the United States the normal annual requirement for new houses is between 300,000 and 400,000; and at the present moment, it is estimated, there is a shortage of around 1,750,000 houses. It is, therefore, believed that some 10 or 15 years will be required for house construction activities to catch up with the country's needs.

Millions of Buildings to Repair

Considering existing buildings and their condition, Mr. Canaday declared that in the United States there are about 29 million buildings of all classes of occupancy—residential, commercial, industrial, educational, and so on. Of these 29 million buildings, 16 million are in urgent need of repair; but again, of the 16 million buildings, about 3 million are too far gone to be worth repairing, leaving 13 million structures that are definitely in need of repair and rehabilitation.

Because of the conditions just described, the building rehabilitation market has been described—and properly so—as "the greatest waiting market."

Organizing City Campaigns

For the purpose of organizing all industrial groups in the Better Housing Program inaugurated by the Federal Housing Administration, campaigns are being organized in every city. Chairmen of local committees had been appointed in 1,200 cities at the time of the Chicago meeting, and the city campaigns were rapidly getting under way.

The forthcoming campaign for stimulating the construction of new buildings, Mr. Canaday announced, will be launched about the first of November.

An effective aid for use in city campaigns is seen in a series of four sound pictures, known as visomatic productions, prepared especially for use in these campaigns by the Federal Housing Administration.

The first of the sound pictures treats the modernization program as it affects the property owner, and requires 75 minutes for showing. Specific instructions are given for obtaining loans, suggestions are made for improvements, and the effect of the program is convincingly presented.

A series of charts, showing community campaign organization set-ups, with suggestions for developing local modernization drives, is the feature of the second production, which requires 30 minutes for showing.

The third production shows financial institutions how they can aid in the program. This one takes 45 minutes to show. The last of the series is produced for the benefit of dealers and contractors, and also requires 45 minutes running time. It tells this group how it may obtain the benefits of the program and at the same time aid the property owner in his plans for property improvement.

The visomatic outfits are being placed in the hands of Regional, State and District directors of the Federal Housing Administration, and a system has been worked out whereby local campaign committees may procure them from Western Union offices all over the country, with an experienced operator available with each.

Feeling of Confidence Prevails

It may be said without exaggeration that the Chicago meeting of September 18 was surcharged with enthusiasm, with a feeling that here, at last, is a recovery movement that is destined to succeed in full measure. In this respect it surpassed anything experienced since the beginning of the depression. Doubtless the causes underlying this feeling are, first, that definite provision is made for releasing private credit for the work; and second, that the Federal Housing Administration has taken this aggressive and forceful action in organizing a nation-wide campaign.

Concrete Pavement Construction Studied and Analyzed

Bureau of Public Roads Examines Causes of Variations in Construction Efficiency—Great Improvement Noted in Recent Years—Elements of Unit Costs

STUDIES of production in highway construction have been made by the division of management of the Bureau of Public Roads from 1923 to the present year. These studies have included grading and surfacing of nearly all types of highways in practically all sections of the United States.

During 1930 approximately 10,000 miles of portland cement concrete pavements were laid on rural highways of which 8,500 miles were on state systems. In 1930 the average cost per mile of a 20-ft. concrete surface, exclusive of engineering, drainage structures, and rough grading, was about $22,500, a total cost of approximately $225,000,000 for the year. A greater efficiency in such large-scale production will result in correspondingly lessened costs to the public.

In the studies here reported, data were collected relative to personnel, equipment, and efficiency of operation. The causes of efficiency on certain projects were analyzed. Between 1923 and 1929 numerous changes were made in types and sizes of equipment used and in methods of construction. From 1929 to June, 1934, changes have not been so extensive. This discussion is based upon investigations made during the latter period.

Causes of Inefficiency

Constant and proper supervision is the key to efficient operation. The type of supervision on nearly every project listed in Table 1 is indicated with fair accuracy by the figure for over-all efficiency of operation of major equipment. A superintendent who understands highway construction, who realizes the importance of utilizing available working time to the fullest extent, and who has the ability to foresee and to prevent delays, is highly valuable.

Adequate supervision has not always been employed. The first reason is that contracting firms, in general, have not always realized the value of adequate supervision of construction. Administrative officers devote a major portion of their time to obtaining contracts and purchasing materials and partially neglect measures for attaining efficiency in construction. It has been customary to refer to highway construction as a "risky business," and there has been a tendency on the part of highway contractors to place much of the blame for inefficient operation on the element of risk rather than on a lack of proper supervision.

Another reason for low efficiency may be that there is no large supply of highway superintendents who have a natural aptitude for the work, together with adequate experience in methods of construction and such special training in production work as enables them to appreciate the value of advance planning and of full use of available working time. Possibly the intermittent character of concrete road construction has led qualified men to seek continuous employment in other lines of work.

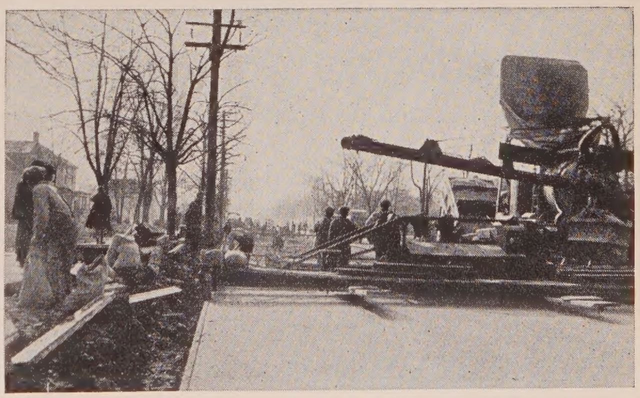
Inspectional Interference

Another factor affects the efficiency with which highway construction work is done. This can be termed "inspectional interference."

Inspectional interference is not to be confused with proper and adequate action in the enforcement of specifications. Proper inspection is a necessity. Inspectional interference, on the other hand, is the overstepping of the engineer's or inspector's authority to enforce specifications. Arbitrary requirements may be imposed on the contractor.

The reasons for such interference are natural ones. In some instances specifications do not state clearly what is desired. They may be contradictory also. Unnecessary interference has been found on many of the projects studied. The lost time caused by such interference has been reported under the type of delay which it caused.

Unnecessary interference causes a loss of working time and also tends to discourage the employment of adequate supervision when the efforts and planning of a competent superintendent can be easily frustrated by a well-meaning but over-conservative and autocratic resident engineer or inspector.



Placing concrete pavement in winter—a practice that is growing

Many examples of unnecessary interference could be cited. Contractors are sometimes required to mix the concrete longer than the specified mixing time, because, in the inspector's opinion, it results in better concrete. It actually results, however, in decreased production and increased costs for labor and equipment. The hours of

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Condensed from report by William A. Blanchette, Highway Engineer, U. S. Bureau of Public Roads, in July (1934) issue of *Public Roads.*

work are sometimes arbitrarily regulated. Instances have been observed where production has been stopped for extended periods in order that the templates and finishing-machine screeds might be checked, although there was ample opportunity for checking during non-operating time.

The daily operating cost for labor and equipment on a concrete paving project is approximately $580, as will be shown later. The cost varies but little whether the production per day is 250 or 500 cu. yd. of concrete.

Unit Costs Per Square Yard

State practices vary with regard to pavement thickness, cement factor, length of mixing time, size of batch, amount of reinforcing, and joint material used, etc., and it is difficult to calculate accurately the unit cost for concrete pavements for the country as a whole. During 1930, 10,600,000 sq. yd. of plain cement concrete pavement were laid on Federal-aid projects at an average cost of $1.78 per sq. yd. Five and one-half million square yards of reinforced concrete pavement were laid on Federal-aid projects at an average cost of $2.16 per sq. yd. This gives a weighted average for all Federal-aid concrete pavements of approximately $1.90 per sq. yd. On the assumption that these unit prices are representative of prices for concrete pavements built by state and local authorities and that the proportions of plain and reinforced pavements for the total mileage built are about the same as for the Federal-aid mileage, the price of $1.90 per sq. yd. will be used in the detailed analysis of costs.

The distribution of this unit cost in respect to the various items of expense is shown in Table 1. The percentages have been calculated from data collected in cost studies. On individual projects, costs and their distribution will vary considerably from these figures, but the table is believed to be representative of average conditions.

TABLE 1—DISTRIBUTION OF AVERAGE COST OF CEMENT CONCRETE PAVEMENTS ON FEDERAL-AID PROJECTS IN 1930 OF $1.90 PER SQ. YD.[1]

	Cost	Per cent
Cement	$0.435	23
Transportation of cement[2]	.135	7
Total	.570	30
Coarse aggregate	.190	10
Transportation of coarse aggregate[2]	.190	10
Total	.380	20
Fine aggregate	.075	4
Transportation of fine aggregate[2]	.095	5
Total	.170	9
Cost and transportation of cement and aggregate	1.120	59
Reinforcing steel, joint material, etc.	.115	6
Depreciation of equipment	.170	9
Labor and supervision	.210	11
Batch delivery (labor and equiment)	.135	7
Overhead, interest, bond, cost of set-up, etc.	.075	4
Return to contractor, including salary	.075	4
Total	$1.900	100

[1] Based on bid prices and includes cost of fine grading.
[2] Transportation to batching plant.

Labor and Equipment Costs

The cost of labor, including supervision, is 11 per cent of the pavement cost. The number of men employed is usually that necessary to handle maximum paver production and remains relatively constant. It does not fluctuate as the hourly or daily rate of production fluctuates because of delays. The daily labor cost can therefore be considered as an almost constant amount. As production decreases, the unit cost for labor increases.

The cost of equipment is about 9 per cent of the pavement cost. The most logical way to reduce this cost is to increase the efficiency with which equipment is operated by using a greater percentage of available working time. Annual or monthly expense for equipment is nearly constant except for field repairs, fuel, and lubricants. Costs do not vary materially with production obtained. The unit cost for depreciation, overhauling, major repairs, interest, taxes, storage, and insurance therefore varies almost inversely with the rate of production.

With an over-all efficiency of operation of major equipment of 78 per cent and a daily pay-roll cost of $334.23, the unit labor cost is $1.11 per cu. yd. With an over-all efficiency of operation of 90 per cent the unit cost would be 96 cents.

TABLE 2—PAY-ROLL COSTS ON AN ASSUMED TYPICAL PROJECT FOR EACH PRODUCTIVE DAY. BASED ON 136 PRODUCTIVE DAYS PER SEASON

Position	Number	Daily rate	Days for which pay is received during season	Non-productive days during season for which pay is received	Total cost of non-productive time	Pro-rated cost of non-productive time to each productive day	Daily cost of productive time	Total cost for each productive day
Superintendent	1	$12.00	245	109	$1,308	$9.62	$12.00	$21.62
Timekeeper	1	5.00	207	71	355	2.61	5.00	7.61
Foremen	4	6.00	207	71	1,704	12.53	24.00	36.53
Crane operator	1	9.00	207	71	639	4.69	9.00	13.69
Paver operator	1	7.00	207	71	497	3.65	7.00	10.65
Mechanic	1	6.00	207	71	426	3.13	6.00	9.13
Other machine operators	7	5.00	136	0	0	0	35.00	35.00
Semi-skilled and heavy common labor	18	4.50	136	0	0	0	81.00	81.00
Ordinary common labor	34	3.50	136	0	0	0	119.00	119.00
Total	68	——	——	——	$4,929	$36.23	$297.50	$334.23

The cost for labor and equipment on concrete pavement construction during 1930 is estimated to have been $44,600,000. Had the general over-all efficiency of operation of major equipment been 90 per cent instead of what it actually was it is reasonable to suppose that the total labor and equipment costs would have been reduced by at least $4,000,000.

Observations and Conclusions

The following observations and conclusions are a result of these studies:

(1) The equipment used in concrete surfacing is reasonably well standardized as to type, capacity, and number of units.

(2) The number of men employed on a concrete paving job varies between wide limits. The average personnel, exclusive of truck drivers, on the 34 projects analyzed numbered 68 men, with a minimum of 42 and a maximum of 98.

(3) The combination of personnel and equipment on concrete paving projects observed was usually adequate to the handling of the maximum possible production of the key equipment.

(4) There is considerable difference in the over-all efficiency with which different contractors operate the major or key equipment. The average over-all efficiency of operation of key equipment on projects studied in 1929

(*Continued on page 27*)

European Housing Experts Describe Redemption of Slum Areas

Outlying Group Housing Projects Also Discussed in Chicago Meeting—Series of Conferences Found Highly Informative

AT a series of conferences held at the Medinah Athletic Club Building in Chicago, on September 7 and 8, a group of internationally-known housing experts discussed from all points of view the intricate problems of low-cost fireproof housing in large cities.

The conferences were sponsored by the Metropolitan Housing Council and the National Association of Housing Officials. The speakers included Dr. Ernst Kahn, of Frankfurt, Germany, in charge of municipal housing projects in that city; Sir Raymond Unwin and Miss A. J. Samuel, of London, England, the latter being manager of 1,200 houses built and operated with public funds; and Henry Wright, Ernest Bohn, and Jacob L. Crane, Americans.

American Tendency Toward Multiple Dwellings

It is well known that the tendency in housing development in large American cities is toward multiple dwellings of the tenement type—clearing away all old structures on an entire block (or several blocks) and building a new multiple-dwelling structure of a fireproof type, provided with modern conveniences and facilities. From this has grown the expression "slum clearance," since in this plan of action the site is completely "cleared" of old structures. The people who move into the new structure, however, are not of the same income class as those who formerly occupied the slum tenements. So far as the latter are concerned, they simply move into other slum quarters.

Remodeling Has Place in Program

Criticism of the tendency just described has been growing, in so far as this form of slum "clearance" fails to provide living quarters for the lowest-income group—the group that formerly occupied the tenements that were cleared away. It is conceded that the close-in multiple-dwelling type of building is needed, for the convenience of people who must, for various reasons, live close to their places of employment; but this multiple type should not be regarded as the solution for all slum problems. Large areas may be found where tenements are in a reasonably good state of repair, and in these cases the housing specialist should investigate the feasibility of remodeling and modernizing the present structures. His aim should be to attain as high a degree of sanitation and fire resistance as possible.

The same may be said of many large areas containing a mixture of single-family and two-family houses and three-family flats, with ample light and air around them. Here it may again be possible that the best answer will be found in repair and remodeling, plus a general clean-up and the establishment of playgrounds for children and recreation spaces for adults.

Grouping Dwellings in Outlying Sections

In the outlying spaces, whether within the city or in suburban communities, the solution in some cases will call for groups of single-family or two-family houses (or a mixture of the two types) built around a large open space, with some garden and utility space in the rear. Other outlying sections will be occupied by people who want individual homes of the cottage type, with a liberal area available for the growing of vegetables and fruits—a part-way approach toward the subsistence homestead, though the ground area will be much smaller.

Thus it is quite out of the question to regard any one type of building as suitable for all cases.

Features of German Housing Projects

Describing the housing problems encountered in Germany, Dr. Kahn stated that prior to the World War that country had 12 to 13 millions homes, most of which are still in existence. Since the war some 3 to 4 million new homes have been built under governmental supervision, indicating that about 25 per cent of the population (mainly in the low-income groups) has been rehoused.

Dr. Kahn cautioned against attempting to build for the *average* family, which does not exist in great numbers. In his housing operations he has kept in mind three general types of families, including (1) the married couple without children, (2) the widow with children, and (3) the normal family, including two parents and children. In consequence, he has planned his apartments as well as groups of single-family and two-family houses with the view of meeting the space requirements of these three types of families, in order that families of similar social strata will be housed in any given building or groups of buildings.

The German housing specialist also warned against the tendency to provide an unnecessary amount of space, asserting that this tendency often made it impossible to obtain the rental needed for a proper financial return. He advised also against the mixing of nationalities, in the interest of neighborhood peace.

Reconstruction and Remodeling in England

Speaking of housing conditions in England, and particularly in London, Sir Raymond Unwin explained that in the rehabilitation of slum structures, the work is done on a basis that will render the buildings livable for at least 20 years. With new buildings the amortization rate is based on the supposition that the structures will be livable for 40, 60, or 80 years, depending on the type of construction.

In some cases, he said, the rehabilitation or new construction, and the subsequent management of buildings, are in the hands of "approved public utilities societies," which are, in effect, limited dividend societies. Where such limited dividend groups do not exist, the management is under local governmental authorities.

Depending on the physical condition of slum areas, Sir Raymond said, such areas are designated as (1) clearance areas, in which all buildings are cleared off; (2) improvement areas, in which some buildings are cleared away and some are rehabilitated; and (3) areas needing reconditioning only, in which all existing buildings are rehabilitated.

Successful Privately-Owned Companies

Sir Raymond also made favorable mention of certain private corporations that have entered this field. Notable among these is the Metropolitan Housing Corporation, Ltd., headed by Claude M. Leigh, a housing expert well known in America. His company has bought up a number of the older flat buildings, has rehabilitated them with new plumbing, new lighting facilities, and general reconditioning. This company does not deal with the very lowest income group, but rather with a grade above that group. The property selected is mainly the kind which, though found in a run-down condition, may readily be reconditioned.

Miss A. J. Samuel, speaking further of conditions in England, expressed herself as favoring new structures rather than attempting to rehabilitate old slum buildings. In her opinion the difference in cost between rehabilitating an old building and erecting a new one is, in most cases, not sufficient to justify rehabilitation on a large scale. On the other hand, great success has been experienced in the reconditioning of rural cottages, especially in the south of England.

Chance for Private Enterprise

Speaking of American cities recently visited, Miss Samuel commented on the rapid deterioration now occurring in areas occupied by fairly good property. In these cases, she feels, it might be quite profitable to private companies to buy and recondition such properties, assuming that existing or new laws permitted the properties to be acquired under condemnation proceedings so that entire areas could be reconditioned and brought under the same management. In general, she declared, slum conditions in American cities are not so congested as in the large cities of England—a fact that favors reconditioning.

Miss Samuel placed much stress on the importance of making a careful selection of tenants, after a personal investigation of each applicant. A few families that are dirty, quarrelsome, or lax in paying rent, will soon demoralize a whole community, she said.

Low Interest Rates Needed

The most serious financial problem, it was admitted by all, is that of providing low-cost housing at rentals which tenants can pay and which will yield a satisfactory return on the investment. Both in England and in Germany, money for low-cost housing is available at 3¼ to 3½ per cent. Dr. Kahn expressed the belief that governments can be of the most constructive aid by providing funds at low rates of interest rather than by granting a direct capital subsidy.

Without some form of government subsidy, however, low-cost housing on a large scale can not be accomplished. On this point the foreign authorities were all agreed.

How Germans Prevent Jerry-Building

The prevention of jerry-building is another serious problem. This point was discussed at some length by Henry K. Holsman, a Chicago architect. In this country, he said, we provide plenty of air and ample room, then we build of materials that undergo rapid deterioration. We use brick and concrete and block for the walls, but we insist on living on wooden floors, even though we know how to build concrete floors that are comfortable and livable. In Europe, he continued, people are accustomed to hard floors; and in consequence, it is possible to build homes that can be kept in a livable condition much longer than the homes we have been building.

Dr. Kahn, in discussing jerry-building, told of the very direct and simple method employed in Germany to eliminate this evil. Contractors are required to give a guarantee against construction defects, covering either two or three years, depending on the character of the buildings. Any repairs necessary within the life of the guarantee must, of course, be paid for out of that guarantee. Because of this practice, it is not necessary to calculate any maintenance expenditures for the first two or three years. The management is, therefore, able to build up a large maintenance fund before expenditures are started.

Federal Housing Booklets

THE following booklets published within the past few weeks are available for free distribution.

Booklet Number	Tile of Booklet
FHE-8	Information Leaflet (Folder)
FHA-101	Property Owners Booklet
FHA-102	Community Campaign Booklet
FHA-103	Builders Booklet
FHA-104	Manufacturers Booklet
FHA-106	Community Planning Booklet
FHA-107	National Housing Act (Text)
FHA-108	Equipment Permitted or Excluded

There is also a printed list of "Approved Financial Institutions," containing the names and locations, by states, of all banks and other institutions that are prepared to extend credit to property owners for improvements under the National Housing Act.

All readers of CONCRETE who are interested in any phase of the federal housing campaign should write to the Federal Housing Administration, New Post Office Building, 12th Street and Pennsylvania Avenue, Washington, D. C., for copies of these booklets.

Roy W. Carlson, distinguished research engineer of the University of California, has been appointed assistant professor at the Massachusetts Institute of Technology according to an announcement by Professor Charles B. Breed, head of the department of civil engineering, on August 31. Professor Carlson is well known for his research in structural materials for large dams, and for the development of electrical measuring instruments to record strains and stress, temperature and pressure within hydraulic structures. At the Institute he will devote his efforts chiefly to research in cement and concrete.

◆ EDITORIAL ◆

Don't Let Winter Stop Your Paving

CONSTRUCTION of concrete roads and pavements need no longer be halted in cold weather. The highway departments of some of our coldest northern states have developed successful working procedure for placing concrete pavements throughout the winter months. This procedure is simple enough, and the extra cost of the necessary precautions and protection can be analyzed and estimated. Several successful methods are described and illustrated in "Concrete," particularly in the issues of January, April, May and June of this year.

Highway engineers who do not familiarize themselves with these methods and lay out their construction programs accordingly are failing in their duty. Highway contractors who do not bid on winter paving work are running counter to their own self-interest.

When We Plan Our Residential Areas

DURING the housing conferences held in Chicago on September 7 and 8, sponsored by the Metropolitan Housing Council and the National Association of Housing Officials, considerable difference of opinion was expressed concerning the rate at which depreciation should be calculated in considering the financial aspects of low-cost housing developments.

Upon this estimated rate of depreciation, and the estimated life-span of the building, depends the size of the sum that must be set aside each year as an amortization fund.

In general, European housing authorities base their calculations on a considerable longer amortization period than is usually sanctioned in this country. In England, Sir Raymond Unwin explained, the amortization period is 40, 60 and 80 years, depending on the type of building under consideration. This is equivalent to saying that with reasonable attention to repair and upkeep, individual homes, tenements and apartment buildings can be kept in livable condition for these periods of time.

In the United States, by way of contrast, the amortization periods established by the administrator of the PWA in 1933 are 25 years for homes of non-fireproof construction (masonry walls and wooden floor and partition construction), 30 years for groups of individual low-cost fireproof homes, and 35 years for new multiple housing developments of fireproof construction built in locations where slums must be destroyed to make room for them. It is probable that the Federal Housing Administrator will adopt similar figures for new homes to be built under the National Housing Act.

Dr. Ernst Kahn, of Germany, declared his belief that depreciation figures commonly employed in the United States are entirely too high—that consistent attention to repairs will keep a house livable for 100 years, provided it is built of construction materials that do not deteriorate. To the cry of obsolescence—the idea that shifting populations and encroaching industrial plants may render a group of houses useless long before they have deteriorated structurally—Dr. Kahn replied that American cities are now "grown up," and most of them are zoned; in consequence, there is little likelihood that our cities will in future years experience the rapid growths and shifts in population seen in times past.

Henry K. Holsman, an American architect, asserted that the real trouble with us is that we build homes provided with ample light and air and modern conveniences, but we use structural materials that deteriorate. In Europe, he said, people are accustomed to living on hard-surface floors. We, too, know how to make floors of concrete that are comfortable and livable, he added, but our people have been living on wooden floors so long that it is difficult to break the habit.

When we learn really to plan our residential areas, and to build dwelling houses as fireproof as large hotels and office buildings, that in itself will stabilize such areas. Then we need no longer worry about obsolescence; and as for depreciation, it will be a very small quantity.

The Butcher, the Baker, the Candlestick Maker

EVERY manufacturer, no matter what he makes, and every merchant, no matter what he sells, will be benefitted by the nation-wide better-housing campaign organized by the Federal Housing Administration and described in an article in this issue.

That is what the officials of the FHA are telling groups of manufacturers and representatives of the construction industry at a number of largely-attended meetings throughout the country, held for the purpose of explaining the working details of the great plan to stimulate repair and modernization.

It makes little difference whether the original expenditure is for concrete construction work, for steel and iron work, for paints, or for interior decoration. The money paid out for materials and wages passes from hand to hand, buying more materials and paying more wages every time it changes hands.

It is the modern version of the old story of paying the butcher, who then pays the baker, who in turn pays the candlestick maker.

PROGRESS — In a Page

Current activities in research, in matters pertaining to concrete and cement, as being carried on or completed by various organized groups.

A. S. T. M. Standing Committees and Their Officers

AS a result of the elections of officers of standing committees of the American Society for Testing Materials, which takes place in the even years, several new officers have been chosen to direct the activities of certain committees. The names of these new men in the list given below are designated by an asterisk (*). All other committee officers listed have been re-elected for the ensuing term of two years, 1934-1936.

COMMITTEE A-1 ON STEEL. (Organized in 1898; present membership, 200.) Chairman: H. H. Morgan, Manager, Rail and Fastenings Dept., Robert W. Hunt Co., Chicago, Ill.; Vice-Chairmen: E. F. Kenney, Metallurgical Engineer, Bethlehem Steel Co., Inc.; H. W. Faus, Engineer of Tests, New York Central Lines; Secretary: H. P. Bigler, Secretary, Rail-Steel Bar Association, 228 N. La Salle St., Chicago, Ill.

COMMITTEE C-1 ON CEMENT. (Organized in 1902; present membership, 81.) Chairman: P. H. Bates, Chief, Clay and Silicate Products Division, National Bureau of Standards, Washington, D. C.; Vice-Chairmen: C. F. Conn, President, Giant Portland Cement Co., Philadelphia, Penna.; F. V. Reagel, Engineer of Materials and Tests, Missouri State Highway Department; Secretary: G. A. Saeger, Assistant to Deputy Administrator, National Recovery Administration, Washington, D. C.

COMMITTEE C-2 ON REINFORCED CONCRETE. (Organized in 1903; present membership, 13.) Chairman: S. C. Hollister, Director, School of Engineering, Cornell University, Ithaca, N. Y.; Vice-Chairman: R. W. Lesley, Director, Giant Portland Cement Co., Philadelphia, Penna.; Secretary: D. E. Parsons, Chief, Masonry Construction Section, National Bureau of Standards, Washington, D. C.

COMMITTEE C-5 ON FIRE TESTS OF MATERIALS AND CONSTRUCTION. (Organized in 1904; present membership, 28.) Chairman: R. P. Miller, Consulting Engineer, New York; Secretary: Fitzhugh Taylor, Protection Engineer, Underwriters' Laboratories, 207 East Ohio St., Chicago, Ill.

COMMITTEE C-6 ON DRAIN TILE. (Organized in 1911; present membership, 17.) Chairman: Anson Marston, Senior Dean of Engineering, Iowa State College, Ames, Iowa; Secretary; W. J. Schlick, Drainage Engineer, Engineering Experiment Station, Iowa State College, Ames, Iowa; Assistant Secretary: D. A. Abrams, Consulting Engineer, New York.

COMMITTEE C-7 ON LIME. (Organized in 1912; present membership, 40.) Chairman: James R. Withrow, Professor of Chemical Engineering, Ohio State University, Columbus, Ohio; Vice-Chairmen: E. E. Eakins, Chemist; *L. S. Wells, Chief, Lime and Gypsum Products Section, National Bureau of Standards, Washington, D. C.; Secretary: *Lee S. Trainor, Chief Engineer, Construction Dept., National Lime Association, 927 15th Street, N.W., Washington, D. C.

COMMITTEE C-9 ON CONCRETE AND CONCRETE AGGREGATES. (Organized in 1915; present membership, 33.) Chairman: D. E. Parsons, Chief, Masonry Construction Section, National Bureau of Standcil, Washington, D. C.; Vice-Chairman: Stanton Walker, Director, Engineering and Research Division, National Sand and Gravel Association, Washington, D. C.; Secretary: R. R. Litehiser, Chief Engineer, Bureau of Tests, Ohio State Highway Testing Laboratory, Columbus, Ohio.

COMMITTEE C-10 ON HOLLOW MASONRY BUILDING UNITS. (Organized in 1915; present membership, 33.) Chairman: D. E. Parsons, Chief, Masonry Construction Section, National Bureau of Standards, Washington, D. C.; Vice-Chairman: R. E. Schmidt, Architect, Schmidt, Garden & Erikson, Chicago, Ill.; Secretary: F. E. Emery, Secretary and Engineer, Structural Clay Tile Association, Chicago, Ill.

COMMITTEE C-12 ON MORTARS FOR UNIT MASONRY. (Organized in 1931; present membership, 53.) Chairman: R. E. Davis, Professor of Civil Engineering, University of California, Berkeley, Calif.; Vice-Chairmen: H. D. Baylor, Vice-President, Louisville Cement Co.; T. R. Lawson, Head, Department of Civil Engineering, Rensselaer Polytechnic Institute, Troy, N. Y.; Secretary, F. Leo Smith, Technical Secretary, American Institute of Architects, Structural Service Dept., Washington, D. C.

COMMITTEE C-13 ON CONCRETE PIPE. (Organized in 1931; present membership 21.) Chairman: Asa E. Phillips, Consulting Engineer, Washington, D. C. Secretary: M. W. Loving, Secretary, American Concrete Pipe Association, 33 W. Grand Ave., Chicago Ill.

COMMITTEE E-1 ON METHODS OF TESTING. (Organized in 1904; present membership, 57.) Chairman: W. H. Fulweiler, Chemical Engineer, United Gas Improvement Co. Vice-Chairman: H. F. Moore, Professor of Engineering Materials, University of Illinois, Urbana, Ill. Ex-Officio Secretary: R. E. Hess, American Society for Testing Materials, 260 So. Broad St., Philadelphia, Penna.

COMMITTEE E-8 ON NOMENCLATURE AND DEFINITIONS. (Organized in 1920; present membership, 45.) Chairman: Cloyd M. Chapman, Consulting Engineer, New York; Vice-Chairman: G. W. Thompson, Chief Chemist, National Lead Co.; Secretary: R. E. Hess, American Society for Testing Materials, 260 S. Broad St., Philadelphia, Penna.

COMMITTEE E-9 ON RESEARCH. (Organized in 1924; present membership, 6.) Chairman: *P. H. Bates, Chief, Clay and Silicate Products Division, National Bureau of Standards, Washington, D. C.; Ex-Officio Secretary: C. L. Warwick, American Society for Testing Materials, 260 S. Broad St., Philadelphia, Penna.

COMMITTEE E-10 ON STANDARDS. (Organized in 1929; present membership, 7.) Chairman: T. R. Lawson, Head, Department of Civil Engineering, Rensselaer Polytechnic Institute, Troy, N. Y.; Ex-Officio Secretary: C. L. Warwick, American Society for Testing Materials, 260 S. Broad St., Philadelphia, Penna.

Fine Clay in Concrete Not Necessarily Harmful

THE effect of fine clay in concrete has been studied in a series of tests conducted for a period of several years by G. W. Parkinson at Lehigh University, Bethlehem, Penna.

Results of the investigation indicate that present specifications may be unnecessarily severe in the limitations placed on the allowable percentage of material passing the No. 100 sieve, in the case of fine aggregates. This is especially true where the fine material is clay or fine sand, of the character often added to concrete in the form of commercial admixtures, to improve the workability.

Financial Houses Co-operate with Housing Administration

THE Federal Housing Administration, New Post Office Building, 12th Street and Pennsylvania Avenue, Washington, D. C., in a report issued under date of September 12, 1934, discloses that 6,231 national and state banks, building and loan associations, and other financial houses, had then accepted contracts of insurance under the terms of the National Housing Act, through which they agree to extend credit to property owners under the modernization credit plan.

Names of co-operating financial houses in individual cities or localities can be obtained from the Federal Housing Administration.

Heating Concrete Aggregates in Open Stock Piles

Use of Improvised Furnaces, Steam Jets, Steam-Pipe Grills, and Rotary Driers — Inadequate Capacity Is Prevailing Error

ONE of the most frequent instances involving the heating of aggregates during concrete construction operations in winter is that of heating these materials in open stock piles. The heating devices usually employed for this purpose are the following:

(1) Furnaces over which the fine and coarse aggregates are shoveled for heating.

(2) Steam jets inserted in the stock piles.

(3) Steam-pipe grills over which the materials are stocked.

(4) Rotary driers have been employed in rare instances.

Heating with Improvised Furnaces

Considering the devices just mentioned, the use of a furnace is generally limited to small concrete jobs. Usually the furnace is built on the job as a part of the construction facilities, and it often consists of nothing more than a large iron pipe with an improvised chimney at one end, and with wood fires inside. Capacity may be increased by placing several such units side by side, with an interval of several feet between them.

Use of Specially-Built Furnaces

Larger furnaces may be built of masonry walls, with a top of some type that is a good conductor of heat. In the construction of a dam in Colorado an open-top masonry furnace 10 ft. wide and 20 ft. long was built with walls 2 ft. 6 in. high. Steel I-beams were placed across the top, and a grill was made with 400 lin. ft. of 1-in. pipe placed on the I-beams. Boiler plate sheet iron 3/16 in. thick was then placed on the grill, and the aggregates to be heated were spread over the sheet iron. A wood fire was kept going in the furnaces, and water was circulated through the 1-in. pipe comprising the grill. In this way the mixing water also was heated. The mixer, with a capacity of 9 cu. ft. and charged with wheelbarrows, turned out concrete at a temperature of around 80 deg. F.

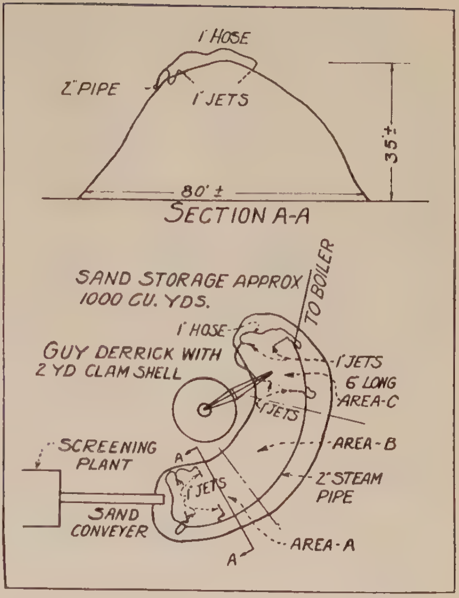
The use of furnaces makes it necessary to adhere to the following procedure:

(1) There must be a constant process of removing warm material and piling cold material.

(2) Careful watching is necessary to make sure that no particles of aggregate are injured by overheating.

Heating with Steam Jets

The steam jet method of heating aggregates serves a wider range of demands than does furnace heating. Overheating of individual particles of aggregate is not possible. It is not necessary to shift the stock piles; instead, the steam jets are shifted.



Method of heating aggregates in stock piles

A good type of jet is a 1-in. to 1½-in. pipe 6 ft. long, drawn to a closed point at one end and fitted for a hose connection at the other end. Staggered perforations, with holes of 3/16-in. to ¼-in. diameter, are drilled at intervals of 1½ ft. A hose connects the jet pipe with the main steam line. These jets are pushed into the piles of aggregate when and where needed, and steam is turned on as long as it is required. A good practice is to keep two jets in the pile of coarse aggregate, and one in the fine aggregate, at the points where the aggregates are being taken away. In all cases the stock piles being heated should be kept covered with tarpaulins, which can be pulled aside for re-stocking or for removal of heated materials.

Steam jets are also convenient devices for heating mixing water, for thawing, and for general heating, the jets being placed, kept in place, and shifted as required.

Steam-Pipe Grills for Large Storage

Steam-pipe grills constitute more elaborate heating systems for larger storage piles than would be considered with either furnace or steam-jet heating. Usually the steam-pipe grill systems are laid out on the ground or on planking over an area slightly smaller than the base of the stock pile. A rectangular area is most common.

The equipment ordinarily installed by the Turner Construction Co. for heating aggregates on a large construction project runs about as follows: A 50-hp. boiler carrying from 50 to 60 lb. of steam is necessary. On smaller projects a boiler of 18 to 25 hp. carrying around 35 lb. pressure will answer the purpose; but on any building of considerable size a boiler of less than 50 hp. must be pushed hard to provide enough steam to heat the stock piles and water, and to supply steam to floor lines for cleaning and heating forms.

For heating aggregates, the steam-pipe grill is made up of 1½-in. pipes spaced 4 ft. apart and perforated with ⅜-in. to ¼-in. holes staggered every 18 in. In cases where sand clogs the holes, hacksaw slots have met the difficulty.

Adapted from *Winter Construction Methods*, by Charles S. Hill.

The temperature of fine and coarse aggregates should range from 35 to 50 deg. F., and that of the water should be from 100 to 150 deg. F. Heating units should, therefore, be made large enough to get these temperatures with the outputs planned. Inadequate capacity is the prevailing error where steam-pipe grills are used, the grill area being too small, or the steam pressure too low.

Good practice with steam-pipe grills calls for the following procedure:

(1) Spread the material over the grill uniformly a few feet deep. Do not heap it into a cone-shaped pile.

(2) Cover the pile with tarpaulins at night, and at other times whenever practicable.

(3) Provide enough boiler pressure and capacity continuously to supply strong jets from the pipe perforations.

(4) Allow 24 hours for heating each day's draw-off of material for concrete.

Rotary Driers in Special Cases

The use of rotary driers occurs only in special instances, as in cases where the output of concrete is so fast that aggregates can not be heated rapidly enough by other methods. Where a rotary drier is installed, the investment is obviously quite large. Furthermore, the output of the drier must be used continuously, as produced, because there is no provision for the storage of heated stock.

◆ CODE NEWS FOR THE INDUSTRY ◆

Addresses of Code Authorities

FOLLOWING are the addresses of the code authorities of industries and branches of industries related or of interest to the concrete construction industry. When writing to a code authority, include the words "code authority" in the address, thus: Code Authority, Construction Industry, National Press Building, Washington, D. C.

Builders' Supplies Trade
Room 1907—Investment Building
Pittsburgh, Penna.

Cement-Gun Contractors Industry
5550 Bartlett Street
Pittsburgh, Penna.

Cement Manufacturing Industry
11 East 44th Street
New York, N. Y.

Concrete Burial Vault Industry
(Chairman of Code Committee is L. A. Chick, care of Blairsville Concrete Products Co.
100 North East Lane, Blairsville, Penna.)

Concrete Masonry Industry
211 Edgemont Place
Teaneck, N. J.

Concrete Pipe Industry
33 W. Grand Avenue
Chicago, Ill.

Construction Industry
National Press Building
Washington, D. C.

Construction Machinery Distributors Trade
207 W. Pearl Street
New York, N. Y.

Crushed Stone, Sand and Gravel, and Slag Industry
Munsey Building
Washington, D. C.

General Contractors' Industry
222 Munsey Building
Washington. D. C.

Ready-Mixed Concrete Industry
951 Munsey Building
Washington, D. C.

Reinforcing Materials Fabricating Industry
201 North Wells Street
Chicago, Ill.

Road Machinery Industry
410 No. Michigan Avenue
Chicago, Ill.

Waterproofing, Dampproofing, Caulking Compounds and Concrete Floor Treatments Industry
11 West 42nd Street
New York, N. Y.

Ready-Mixed Concrete Industry Wins Its Point

THE code authority of the ready-mixed concrete industry has won its point in its argument over paragraph (3) of administrative order X-36, dated May 26, 1934. In that order exemption from paying dues to the ready-mixed concrete industry was granted to material dealers and others who produce ready-mixed concrete but whose principal line of business is in some other industry.

The foregoing exemption was set aside in an order issued as Order No. 311-16 by George L. Berry, Division Administrator. Under the provisions of this new order, all producers are required to pay their proportionate share of the costs of administering the ready-mixed code.

Concrete Masonry Code Amended

AMENDMENT No. 1 to the concrete masonry code was approved as of August 13, 1934. The purpose of this amendment is to authorize the Code Authority of the industry to submit a budget and method of assessment.

After approval by the Administrator of the National Industrial Recovery Act, the Code Authority may, if necessary, institute legal action to collect dues.

Where Complaints Should Be Filed

TO investigate complaints of NRA code violations, the Compliance Division of the NRA has established 54 offices under the State Compliance Directors. One is in each state, and extra branch offices have been set up in New York, Pennsylvania, Texas, and California. When complaints are not settled by the representatives of these offices, or when appeals are taken from the decisions of the State Directors, the cases are referred to state adjustment boards, consisting of representatives of labor, capital, and the consuming public. The court of last resort is the Compliance Council of the NRA at Washington.

Placing Colored Concrete Topping

Complete Specifications Offered by Portland Cement Association — of Special Value to Architects and Contractors

A PROPOSED specification for placing colored concrete topping on structural concrete floors has been prepared by the Portland Cement Association for the information and use of architects and concrete contractors. Explanatory notes provide additional information, in the nature of working procedure. This feature is of particular value to contractors.

The complete specifications, including the explanatory notes, are given in the numbered paragraphs that follow:

(Beginning of Specifications)

1. *Portland Cement* shall be of American manufacture conforming to the American Society for Testing Materials Standard Specifications for Portland Cement (Serial Designation C9-30) and subsequent revisions thereof. Colored portland cement especially prepared for colored concrete may be used. The colored cement shall be in the original containers.

2. *Aggregates* shall be clean, hard, durable and well graded. The sand shall be graded with at least 95 per cent passing the No. 4 sieve and not more than 15 per cent passing a 50-mesh sieve and not more than 3 per cent passing the 100-mesh sieve. The coarse aggregate shall be graded with at least 95 per cent passing a ⅜-in. sieve and not more than 10 per cent passing a No. 8 sieve.

3. *Water* shall be clean and suitable for drinking.

Note: Excessive iron concentration in the mixing water will tend to produce discoloration.

4. *Pigments* shall be commercially pure natural or synthetic mineral oxides or other coloring materials manufactured for use in portland cement concrete and proved satisfactory. Pigments shall be in the manufacturer's original container.

Note: The amount of color required should be determined with sample slabs made under job conditions and allowed to dry. From 3 to 6 lb. of pigment per sack or portland cement will usually be sufficient where dark pigments are used and 5 to 9 lb. for light pigments. Mortar colors containing a large percentage of filler will not produce satisfactory results.

5. *Mixing Pigment.* Pigment shall be thoroughly mixed with the dry cement, prior to placing in concrete mixer. The pigment shall be proportioned by weight and the same amount used in each batch.

Note: On important work, the pigment should be mixed with the dry cement in a color mixer. If color mixer is not available, the use of factory-prepared colored cement is recommended. In less important work the dry cement and pigment may be mixed by passing through a ⅛-in. screen until color is uniform.

6. *Concrete Mixture* shall be made with not more than 5 gallons of water for each sack of portland cement, including the water in the aggregate. The sand and coarse aggregate shall be combined in such proportions as to produce a concrete mix that will place and finish satisfactorily. In no case shall the volume of coarse aggregate be less than the volume of fine aggregate.

After the desirable proportions are determined, each succeeding batch shall contain the same amount of each aggregate. The consistency of the mixture shall be such that no dry materials are required on the surface for finishing. The concrete shall be mixed for not less than 2 minutes after all materials have been placed in the mixer.

Note: Water can be measured easily and quickly with an ordinary dipping bucket marked with 1-quart graduations. Sand, as delivered on the job, usually contains about ½ gallon of water per cubic foot. Under average conditions a mix of 1 sack of portland cement, 4½ gallons of mixing water, 1 cu. ft. of job sand and 1¾ cu. ft. of coarse aggregate will produce a mix with the desired consistency and finishing characteristics. On important work, the aggregates should be proportioned by weight.

7. *Placing.* The concrete base shall be cleaned, wetted, all excess water removed and a neat cement grout broomed on just prior to placing the topping.

8. *Topping Thickness* shall be not less than 1 in.

9. *Finishing.* The topping shall be screeded and compacted with a wood float or an approved mechanical floating machine. Troweling shall be delayed until water sheen produced by floating is disappearing. The finish shall be brought to a smooth surface free from defects or blemishes.

Note: The proper finishing of concrete floors is an art and is the most important single operation in the production of a satisfactory finish. By deferring troweling until water sheen is disappearing, the topping will have hardened sufficiently to prevent fine particles from being brought to the surface. The troweling then has the effect of forcing the coarse particles of aggregate into the mass and covering them with just enough mortar to produce a dense, durable finish.

10. *Curing.* As soon as the topping has hardened to prevent damage thereby, it shall be covered with at least 1 in. of wet sand, or other covering satisfactory to the engineer or architect, and shall be kept continually wet, for at least 7 days.

Note: On important work, it is advisable to use an approved stainless waterproof concrete curing paper to cover the work and provide means to keep it sealed tightly for not less than 7 days.

(End of Specifications)

The foregoing specifications have just been published in a revised edition of the Portland Cement Association's booklet entitled *Concrete Facts for Concrete Contractors,* copies of which may be obtained from the Association.

Book on Winter Concreting

"Winter Construction Methods," by Charles S. Hill, is a book that all contractors and construction companies should have—not one copy, but several.

The book contains a summary of the methods which have proved successful in actual construction experience. It is a manual of cold-weather concreting practice, and a guide to successful concrete construction under the most severe winter weather conditions.

Copies of this book may be obtained through the Book Department of CONCRETE, 400 West Madison St., Chicago, at the regular price of $3.00 postpaid; but in order to place copies of the book into the hands of as many construction people as possible, "Concrete" offers one year's subscription along with the book at the combined price of $4.50. This means a saving of $1.50.

The offer applies to renewals and extensions of present subscriptions as well as to new subscriptions.—*Editor.*

Effect of Amount of Fine Aggregate on Quality of Concrete

By JOHN C. SPRAGUE
Inspector, U. S. Engineers, Huntington (W. Va.), District

Synopsis*—The question of optimum percentage of fine to coarse aggregate for concrete mixtures has been discussed to a considerable extent, particularly since Abrams' water-cement ratio law has been established as a means for determining the quality of concrete. It is a generally recognized fact that the higher the percentage of fine to total aggregate the greater the necessary water-cement ratio, with a consequent loss in density and strength, and therefore a sacrifice in the durability of the concrete structure. This fact, although it is understood and appreciated in theory, is often ignored in actual practice in the field.*

In this discussion it is intended to point out that the various factors of concrete which determine its durability, are very sensitive to changes in the amount of the fine aggregate, and that the further we deviate from the optimum ratio the more uneconomical the concrete becomes. There is included an appendix, which will appear in the next installment, in which a detailed account of the procedure followed in making the tests is given.

FOR the purpose of this discussion it may be said that concrete mixtures fall generally into two classes —i. e., over-mortared and designed mixtures. It is seldom in designed mixtures that too little mortar is found in the concrete, the natural tendency being to "play safe" by adding plenty of fine aggregate to insure cohesiveness in the mixture. On the other hand there are many instances, particularly where arbitrary mixes such as 1-2-4, 1-3-6, etc., have been used, where mixtures had a deficiency of mortar, resulting from the use of too little fine aggregate because the bulking factor of the material was not taken into consideration.

Either extreme is harmful and should be avoided; an excess of fines makes it necessary to increase the mixing water in order to maintain the desired flowability of the concrete, and consequently the comprehensive strength, the density and the durability are adversely affected; on the other hand a deficiency of fine material will cause honeycomb throughout the structure. This latter condition is even less desirable than having a slight excess of water in the mixture. Either extreme produces poor results and should be avoided.

This discussion deals only with designed and over-mortared mixtures, since it is believed by the writer that there is relatively little tendency in present-day practice to use too little fine material in concrete mixtures.

DISCUSSION OF DATA

In over-mortared mixtures there is more fine aggregate than is required to fill the voids of the coarse aggregate, with the result that, in the concrete as placed, the coarse particles are pushed much farther apart than they lie in their natural state in stock piles. Professor Talbot, of the University of Illinois,[1] has shown for mixtures of this character that the strength of the mortar determines the strength of the concrete. Practical experience in the field seems to bear this out. A properly designed mix contains just enough mortar to bind the coarse particles together in a dense, homogeneous mass with a slight excess to act as a lubricant. If the cement factor is specified, the percentage of fine to total aggregate should be kept as low as is consistent with the desired workability; if the cement factor is not specified the mix should be so designed as to obtain the greatest durability consistent with economy. Unfortunately there is no real working relationship between durability and compressive strength in concrete, and since strength is the yardstick by which we measure the quality of concrete it should be kept fairly high in order to insure that the concrete will be durable; hence the usual specified high cement factor. In making the tests on which this discussion is based (see appendix in next installment) the cement factor was specified and held constant throughout.

Effect of Over-Mortared Mixtures

The statement made above that over-mortared mixtures cause the coarse particles to spread apart is substantiated in Figure 1, Curve A, at the top of the chart. As the percentage of fine to total aggregate was increased the volume of the concrete increased, the increase probably being due to entrained air in the mixture. This increase in the volume of the concrete is reflected in its mass, since the *size* of a body is a measure of mass between bodies of the same materials; thus a body weighing 100 lb. per cu. ft. is twice as dense as one weighing only 50 lb. per cu. ft. On the basis of 100 it will be noted, in Figure 1, that for gravel of 2-in. maximum size, that mix in which 29 per cent fine to total aggregate was used produced a volume of unity, whereas the 40 per cent mixture produced the greatest increase in volume. The intervening percentages of fine total aggregate produced increased volumes as the percentages were increased.

In making these tests, one grading of sand was used for two gravels—i. e., ½-in. and 2-in. maximum sizes. The aggregate was commercial sand and gravel dredged from the Ohio River in the vicinity of Point Pleasant. The physical characteristics of the materials are shown in Tables 1 and 2 and in the appendix which is to appear in the next installment of this article. As an admixture, 40 lb. of extra cement per cubic yard of concrete was used, but this added cement is included in the total cement factor and its hydraulic qualities are utilized in calculating the effective water-cement ratios of the various mixtures, in other words, the total factor includes the specified cement factor plus the additional 40 lb. per cu. yd.

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[1] Talbot, A. N. and Richart, F. E.; Univ. of Illinois Experiment Station, Bulletin No. 137 (1923).

Flowability and Mobility Measured Separately

Workability was used as a basis of comparison between different mixtures. Of the two main influencing factors governing workability, mobility was considered more important, with flowability (slump) acting as a governing agent. For the large gravel (2 in.) the slump was maintained at 3 in. and the water-cement ratio was allowed to vary according to the needs of the mixture; and for the small gravel (½ in.) the slump was allowed to vary and the water-cement ratio was held constant. In maintaining this basis of comparison it was thought that it would be desirable to evaluate separately the mobility and flowability of the concrete, for unless they can be measured separately the workability factor is the summation of the two and the relative effect of either, considered separately, is unknown.

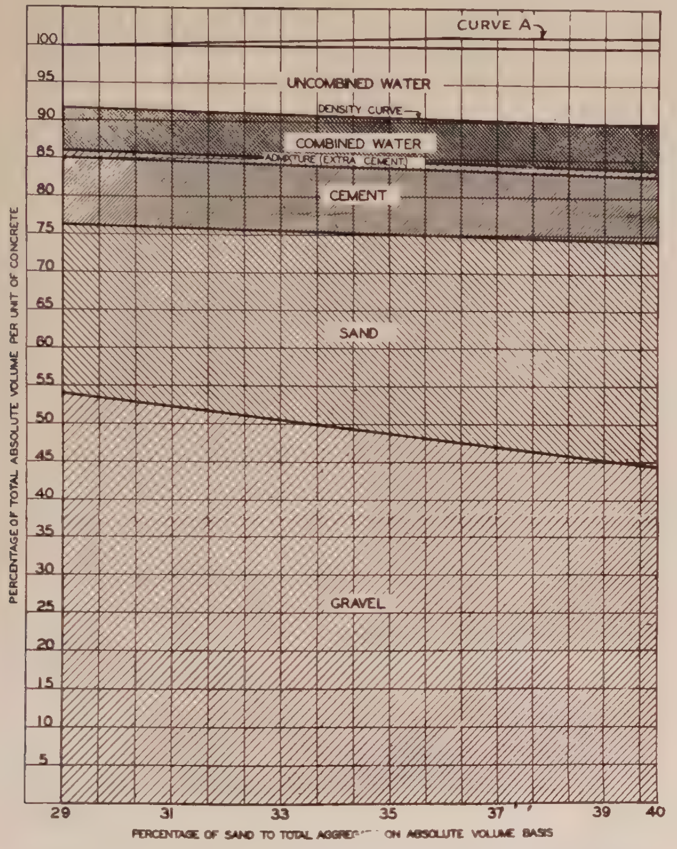

Figure 1. Analysis of concrete mixtures containing various percentages of sand to gravel, the ratio of total aggregate to cement remaining the same except for a small variation due to changing water-cement ratio. Maximum size of gravel is 2 inches

The flowability of the mixtures was measured by the slump cone in accordance with A. S. T. M. Specifications. The mobility was measured by placing a board on the mound of concrete after the slump cone had been removed, and exerting static pressure on the concrete until the mound of concrete was flattened out. The concrete, as it was mashed down, showed segregation for those mixtures containing the lower percentage of sand, with an increase in cohesiveness as the sand was increased and the gravel decreased.

Calculation of Proportions

Realizing that the various methods offered to date for calculating concrete proportions will give only approximate values and that the current method of making trial batches may cause widely varying results due to the small quantity of concrete it is possible to work with, and the personal equation entering therein, the writer set about devising a method which would give more consistent results. The following method was evolved by adapting Fuller's method,[2] which he used when he made his tests for maximum density in concrete mixtures.

The approximate percentage of sand to total aggregate was determined by using Abrams'[3] fineness modulus method. For the materials used this percentage was found to be 35 per cent for 2-in., and 38 per cent for ½-in. gravel. With these two percentages for starting points the range of percentages to use in making the tests were arbitrarily set at from 29 to 40 per cent for 2-in. gravel, and 28 to 38 per cent for ½-in. gravel. All ingredients were reduced to absolute volumes and the proportions calculated on an absolute volume basis. The mix for each percentage of sand to total aggregate is shown by absolute volume (Tables 1 and 2), and was calculated by dividing the absolute volumes of the admixture, sand and gravel by the absolute volume of 1 cu. ft. of commercial cement weighing 94 lb. per cu. ft.

The unit size of the concrete samples used in these tests was arbitrarily set at 0.45 cu. ft., as that volume represented 1/12 and 1/10, respectively (see appendix in next installment), of a one-bag mix for the 2-in. and ½-in. gravel, and was convenient to calculate. A half-cubic-foot steel measure, cylindrical in shape, and meeting the requirements of the American Society for Testing Materials, was used to measure the concrete after it had been mixed. The constituent materials entering the mixtures were all measured by weight and mixed by hand, for three minutes, on a water-tight mixing board. After having been mixed the concrete was measured for flowability and mobility as outlined above. The materials were then placed in the steel measure and compacted until the mass occupied the smallest volume possible. This was done by vibrating the concrete and taking frequent measurements to determine whether or not there was any decrease in the volume after each series of agitations. When the concrete had become so compact that the level dropped only 1/32 of an inch after repeated vibration it was considered to have reached a consistent compactness comparable with other samples treated in like manner. The next step was to weigh the sample and divide this weight by the volume it occupied in terms of 1 cu. ft. The result was the weight of the concrete per cubic foot. Each sample was tested in this manner, thus establishing a comparison of workability and unit weight between the mixtures varying in

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[2] Fuller, W. D. and Thompson, S. E.; Proc. A. S. C. E., 33, 222 (1907).

[3] Abrams, D. A.; Structural Materials Laboratory, Lewis Institute, Chicago, Ill.; Bulletin No. 1, 1919.

TABLE 1—CONCRETE MIXTURES, SHOWING EFFECT OF AMOUNT OF SAND ON WATER-CEMENT RATIO, DENSITY, AND WEIGHT OF CONCRETE

Unit of Sample: 1/12 bag mix. Theoretical volume: 0.45 cu. ft.
Sand—Range in size: 0—No. 4; F.M. = 3.3; Voids 30 per cent; U.W. = 113.5 lb./cu. ft.
Gravel—Range in size: No. 4 to 2 in.; F.M. = 7.9; Voids 31 per cent; U.W. = 112.0 lb./cu. ft.
Apparent specific gravity of sand and gravel: 2.60.
Cement factor: 1.25; Admixture factor: 0.106; Total factor: 1.356.
Slump to be maintained: 3 in. plus or minus.

SIEVE ANALYSIS OF AGGREGATES

Gravel		Sand	
Sieve No.	Per cent Ret.	Sieve No.	Per cent Ret.
3″	0	⅜″	0
2″	7	4	8
1½″	30	8	28
1″	45	14	42
¾″	66	28	62
⅜″	90	48	88
4	100	100	99

(1) Percentage Sand to Total Aggregate	(2) Effective W/C Ratio (by Vol.)	(3) Mix (Absolute Volume)	(4) Actual Vol. of Concr.	(5) Unit Wt., Lb. per Cu. Ft.	(6) Density	(7) Nominal W/C Ratio (by Vol.)
29	0.701	1:0.085:2.47:6.06	0.45	151.1	0.858 .922	0.760
30	.714	1:0.085:2.54:5.95	.45	151.0	.856 .920	.775
31	.724	1:0.085:2.62:5.84	.451	150.3	.854 .917	.785
32	.733	1:0.085:2.70:5.73	.452	150.0	.852 .916	.795
33	.742	1:0.085:2.78:5.62	.453	149.4	.850 .915	.805
34	.747	1:0.085:2.86:5.55	.454	148.9	.849 .913	.810
35	.751	1:0.085:2.94:5.46	.455	148.5	.848 .912	.815
36	.760	1:0.085:3.01:5.36	.456	147.9	.846 .910	.825
37	.768	1:0.085:3.09:5.27	.456	147.6	.844 .907	.835
38	.777	1:0.085:3.17:5.18	.456	147.3	.842 .905	.845
39	.788	1:0.085:3.25:5.08	.457	146.8	.841 .904	.855
40	.799	1:0.085:3.32:4.98	.457	146.6	.839 .902	.867

TABLE 2—CONCRETE MIXTURES, SHOWING EFFECT OF AMOUNT OF SAND ON UNIT WEIGHT AND WORKABILITY OF CONCRETE

Unit of Sample: 1/10 bag mix. Theoretical volume: 0.45 cu. ft.
Sand: Range in size: 0—No. 4; F.M. = 3.3; Voids 30 per cent; U.W. = 113.5 lb./cu. ft.
Gravel: Range in size: No. 4 to ½ in.; F.M. = 6.6 Voids 31 per cent; U.W. = 112.0 lb./cu. ft.
Apparent specific gravity of sand and gravel: 2.60.
Cement factor: 1.5; Admixture factor: 0.106; Total factor: 1.606.
Effective water-cement ratios held constant at 0.733.
Nominal water-cement ratios held constant at 0.785.

SIEVE ANALYSIS OF AGGREGATES

Gravel		Sand	
Sieve No.	Per cent Ret.	Sieve No.	Per cent Ret.
¾″	8	⅜″	0
⅜″	56	4	8
4	97	8	28
8	100	14	42
		28	62
		48	88
		100	99

(1) Percentage Sand to Total Aggregate	(2) Slump (inches)	(3) Mix (Absolute Volume)	(4) Actual Vol. of Concrete	(5) Unit Wt., Lb. per Cu. Ft.	(6) Density
28	3¼	1:0.066:1.85:4.76	0.45	148.5	0.825 .900
29	3	1:0.066:1.92:4.69	.45	148.5	.825 .900
30	4	1:0.066:1.99:4.62	.45	148.5	.825 .900
31	3	1:0.066:2.05:4.56	.45	148.5	.825 .900
32	2½	1:0.066:2.12:4.49	.45	148.5	.825 .900
33	2	1:0.066:2.18:4.43	.45	148.5	.825 .900
34	1½	1:0.066:2.25:4.36	.451	148.0	.825 .900
35	1½	1:0.066:2.33:4.30	.452	147.7	.825 .900
36	1¼	1:0.066:2.38:4.23	.453	147.3	.825 .900
37	1+	1:0.066:2.44:4.17	.454	147.0	.825 .900
38	1—	1:0.066:2.51:4.10	.454	147.0	.825 .900

ratios of sand to total aggregate. Three samples were made for each condition and the average of the results used in compiling data. See column 4, Tables 1 and 2, for the increases in volume above the theoretical volume of 0.45 cu. ft. The same tendency for the volume to increase with added sand is shown graphically in Figure 1.

Where Unit Weight Is Important

The mass, or unit weight, of concrete in structures of the gravity type, such as dams, is an important item and needs to be carefully considered, as it has a marked effect on design and means a real saving or waste of money because the unit weight of the concrete will materially influence the cross-section of such a structure. In designing concrete mixtures for counterweights for bascule bridges it is especially important that the unit weight of the concrete be as high as possible and that the weight be consistent throughout.

The unit weight per cubic foot of the concrete in the various mixtures is shown in column 5, Tables 1 and 2. It will be noted that 29 per cent sand to total aggregate produced a unit weight of 150.1 lb. per cu. ft., and that 40 per cent sand produced only 146.6 lb. per cu. ft. This loss in weight, or mass, is attributed to two causes—i. e., the increase in the water-cement ratio and the increase in the volume of the mixture. In Table 2 the same tendency is noted; but it is not so marked, since the water-cement ratio remains constant throughout all mixtures. The only agent tending to reduce the mass is the bulking of the sample brought about by the fine aggregate pushing the coarse particles apart. It will be seen that from 28 to 33 per cent there is no increase above the theoretical volume of 0.45 cu. ft., and therefore no decrease in the unit weight. This is accounted for by the fact that within this range the mixtures were undersanded. As soon as the concrete takes on a plastic appearance, however, the volume begins to increase with a consequent decrease in unit weight.

The density of the concrete (see Column 6 in the Tables) was calculated from the total (or nominal) water-cement ratio, in which the admixture is included. The top figures in these columns are represented graphically (Figure 1) by the line between combined water and admixture, and the bottom figures by the line (density curve) between combined and uncombined water. That portion of Figure 1 showing combined water was computed on the basis that a cubic foot of loose cement requires approximately 2-1/3 gal. of water for complete hydration and that the result of this chemical process is a new compound forming a solid. It will be observed that the densities follow the same general trend as the unit weights in that they grow less as the water-cement ratios were changed with the sand-gravel ratios, but not in Table 2, where the water-cement ratio was kept constant. In other words, Table 1 indicates that density and unit weight stand the brunt for changes in water and sand, whereas in Table 2 workability stands the brunt, with unit weight being affected to some extent.

In passing it is interesting to note that, although the strength of concrete is increased for richer mixtures, its unit weight and density, as indicated by these tests, are reduced as the cement factor is increased. Compare mixtures having a nominal water-cement ratio of 0.785 in both tables. The mixture having a cement factor of 1.25 (exclusive of admixtures) gave a higher unit weight and density than the mix having a cement factor of 1.5. This is due to the fact that the total water content per unit volume for the richer mix is increased in spite of the fact that the water-cement ratio may be reduced. This is a strong argument for making a close study of the condition peculiar to a given job in order to determine the proper amount of cement to use rather than use some arbitrary amount just because it had been used on some other job.

It was mentioned before that workability was used as a basis of comparison for mixtures containing varying percentages of sand to total aggregate. It was further stated that the slump was held approximately constant for the 2-in. gravel and the water content varied to maintain it; and that the slump for the ½-in. gravel mixtures was allowed to vary. The result was what could be expected. By referring to Table 1 it will be seen that, in order to maintain a 3-in. slump, the nominal water ratio had to be increased from 0.76 to 0.867 for an increase of sand to total aggregate from 29 to 40 per cent. By referring to Table 2 the same tendency is shown by the decrease in slump from 3¼ in. to 1 in. for an increase in sand proportions from 28 per cent to 38 per cent. As the slump decreased (Table 2) the mobility increased with a consequent decrease in segregation. Table 1 indicates the same tendency in a different manner, in that the mobility increased with the increase in the sand content.

For the conditions imposed it was found that for the large gravel 31 per cent sand to total aggregate gave the optimum mix and that any lower percentages, although they produced heavier and denser concrete, would not give a mix which could be worked economically by hand. On the other hand, higher percentages produced an oversanded mixture which was uneconomical from the standpoint of workability, compressive strength, density, unit weight, and shrinkage. Generally speaking, therefore, it may be said that for this type of coarse material the ratio of fine to total aggregate is approximately equal to unity minus the absolute volume of the coarse aggregate. On the other hand, it was found that 34 per cent sand to total aggregate gave the best results for the small gravel, indicating that sand in excess of the voids of the gravel was required. Percentages below this figure produced markedly undersanded mixtures, and higher percentages gave a greater plasticity than was required. An interesting article in this connection is that by W. W. Zass.[4]

CONCLUSIONS

(1) By depending entirely on a calculation method for designing mixtures there is little chance that the optimum percentages of fine to total aggregate will be obtained in every case, or even in the majority of cases.

(2) Some mechanical method with visual inspection might prove more effective for determining the relative proportions of the inert materials.

(3) It is not possible, when using ordinary methods for placing concrete, to use that ratio of fine to total aggregate which will produce the densest, heaviest, strongest and most durable concrete because of the workability factor. It is possible, however, to determine the optimum proportions, or those proportions which will produce the most durable concrete consistent with economy.

(4) The various factors of concrete which determine its quality are very sensitive to changes in the amount of fine aggregate, and the further we deviate from the optimum proportions the more uneconomical the concrete becomes.

(The next—and final—installment will comprise an appendix to this paper, covering the procedure followed in designing concrete mixtures.)

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[4] Zass, W. W.; "New Method of Proportioning Concrete for Road Work," E. N. R., Sept. 1, 1932. Discussion by J. C. Sprague, E. N. R., July 20, 1933.

Cause of Business Uneasiness Rooted in Greed

Head of Credit Men Condemns Both Labor Leaders and Industrial Leaders

TWO strong forces, with a common vice, are causing the current uneasiness about business in general and the NRA in particular. The vice is the greed of certain union labor organizations and of certain business interests, according to Henry H. Heimann, executive manager of the National Association of Credit Men, in his September review of business conditions sent to 20,000 members.

"The NRA is a business man's creation, wholly conceived by business and, in my opinion, not even distantly related to the so-called brain trust," the credit executive points out.

"The salvage from the NRA will be certain regulations as to maximum hours and minimum wages, the abolition of child labor and the elimination of certain highly objectionable trade practices. Price agreements, restriction of output and other measures which seek to insure profits to even the most inefficient unit in a business, will never survive any sensible economic period."

Show Reaction of Calcium Chloride on Portland Cement

Progress Report on Investigation at National Bureau of Standards Discloses Effect on Heat of Hydration and on Physical Properties of Concrete

By PAUL RAPP, Research Associate at the Bureau of Standards for the Calcium Chloride Association, and LANSING S. WELLS, National Bureau of Standards

THE Calcium Chloride Association has maintained a fellowship at the Bureau of Standards to study the reactions of calcium chloride with cements and their constitutents and to obtain more information on the effect of this material on concrete made from present day cements. The results of the complete investigation of the effects of calcium chloride on cements and concrete cannot be given at this time, since the long-time tests have not been completed.

Description of Cements and Calcium Chloride

Eight portland cements (referred to in this report as standard cements) together with one high-early-strength and two white portland cements were studied in this investigation. In selecting these cements an effort was made to obtain the greatest variation possible in composition and physical properties.

Sixty experimental cements of varying composition were furnished by the Portland Cement Association Fellowship at the Bureau of Standards for certain heat studies herein reported.

The calcium chloride used was a commercial flaked hydrated product containing 77.1 per cent $CaCl_2$ and the amounts added to the cements are reported as percentage of $CaCl_2$, by weight of cement.

Effect on Heat Evolved During First Twenty-Four Hours

Heat of Hydration of Sixty Special Cements. The sixty samples of laboratory cements above referred to had a wide range in composition, which made them of especial value in the present study. The analytical data and heats of hydration in the absence of calcium chloride were kindly furnished by the Portland Cement Association Fellowship. The quantity of each cement available was so limited that only one additional calorimetric determination (using one per cent anhydrous calcium chloride) could be made.

The values obtained from these cements (Table I) show the same trends as those reported by Blank[1] and by Wood and his co-workers,[2] namely, that tricalcium aluminate ($3CaO.Al_2O_3$), gives the greatest heat evolved (expressed in calories for each per cent present in each gram of cement), tricalcium silicate ($3CaO.SiO_2$), being next in order. The addition of calcium chloride appears to increase somewhat the heat contributed by dicalcium silicate ($2CaO.SiO_2$) and tetracalcium ferro-aluminate ($4CaO.Al_2O_3.Fe_2O_3$), and to decrease the heat from tricalcium aluminate. The heat contributed by tricalcium silicate shows very little change when calcium chloride is added.

TABLE I—CONTRIBUTION OF INDIVIDUAL COMPOUNDS TO HEAT OF HARDENING

(In calories of each per cent in one gram of cement)

Compound	Value for 0% $CaCl_2$ at 1 Day	Probable Error	Value for 1% $CaCl_2$ at 1 Day	Probable Error	Blank's Value at 1 Day	Wood's Value at 3 Days
Tricalcium Silicate	.80	±.02	.78	±.02	.57	.98
Beta Dicalcium Silicate	.19	±.02	.26	±.02	.095	.195
Tricalcium Aluminate	1.62	±.07	1.47	±.06	2.00	1.70
Tetracalcium Ferro-Aluminate	.01	±.08	.25	±.06	.19	.29

Heat of Hydration of Eleven Commercial Cements. The heat evolved from eleven commercial cements during the first 24 hours of hydration was measured with and without calcium chloride to determine the nature of the change produced by the addition of 0.5, 1, 1.5 and 2 per cent of anhydrous calcium chloride.

TABLE II—CHANGES IN THE TOTAL HEAT EVOLVED AT TWENTY-FOUR HOURS BY ADDITION OF ONE PER CENT OF CALCIUM CHLORIDE TO EXPERIMENTAL CEMENTS

Grouping—Heat Evolved in 24 Hours with No $CaCl_2$ (Calories per g)	No. of Cements in Each Group	Average Changes Produced by 1% $CaCl_2$ (Calories per g)	Average Compound Compositions: Tricalcium Aluminate %	Tetracalcium Ferro-Aluminate %	Beta Dicalcium Silicate %	Tricalcium Silicate %
30-39.9	9	+7	3	15	47	30
40-49.9	12	+5	4	14	35	42
50-59.9	24	+4	10	12	34	42
60-69.9	16	0	10	11	25	52
70-79.9	3	—2	15	7	21	53

As the amount of calcium chloride is increased the rate of heat evolution is increased. The addition of 1.5 per cent of anhydrous calcium chloride increases this rate proportionately more than 2 per cent. The amount of heat developed at 24 hours does not change more than a few calories for the various percentages of calcium chloride added. The other seven standard and the two white cements behave in a similar manner upon the addition of calcium chloride.

Calcium chloride generally increases the rate of temperature rise and decreases the time to reach the maxi-

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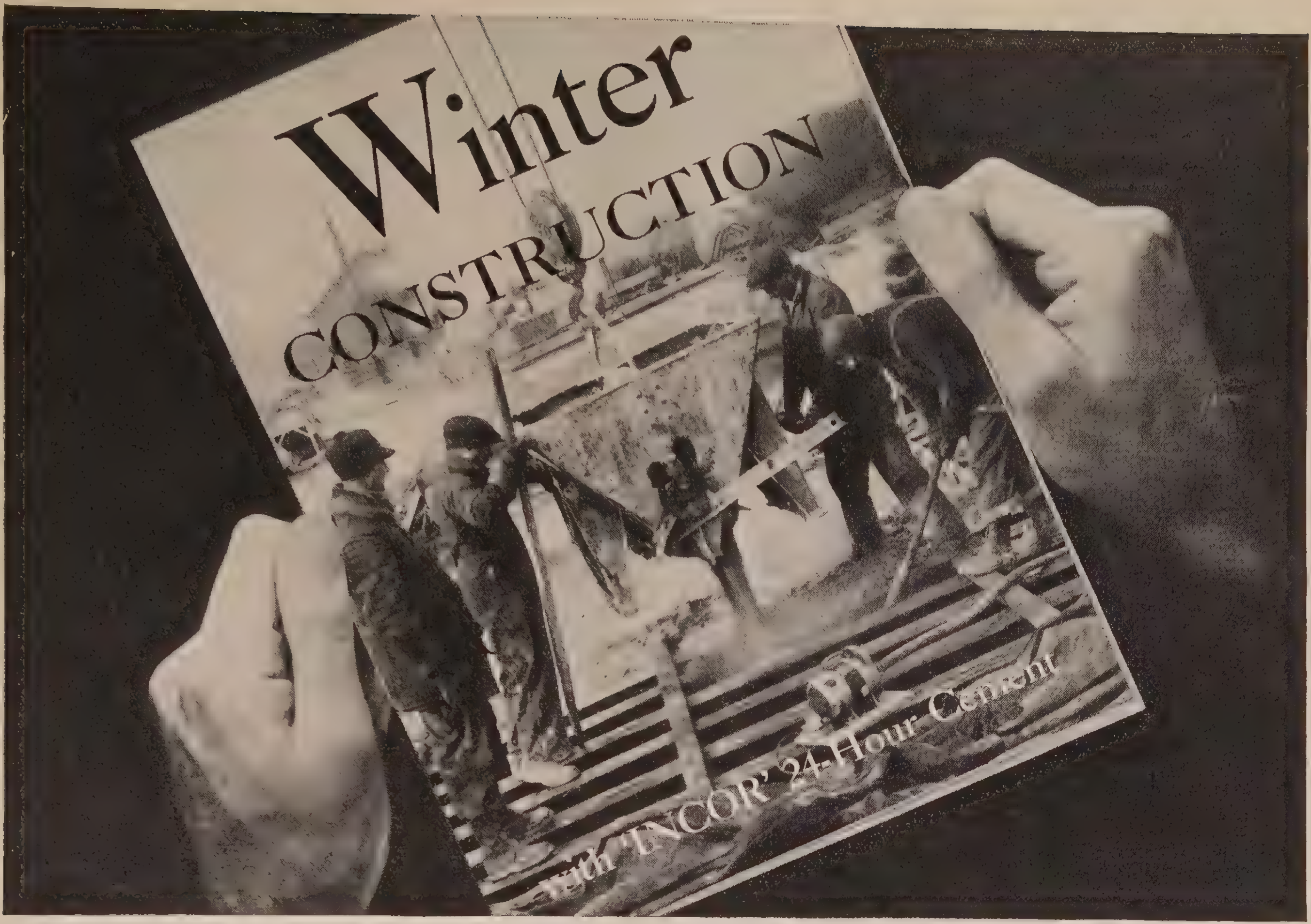
Condensed from *Proceedings* of Thirteenth Annual Meeting of The Highway Research Board.

[1] Comparison of Selected Portland Cements in Mass Concrete Tests, Robert T. Blank, J. Am. Concrete Inst., Vol. 5 (No. 1), page 9, 1933.

[2] Effect of Composition of Portland Cement on Heat Evolved During Hardening. Wood, Steinam and Starke. Ind. Eng. Chem., Vol. 4, page 1207 (1930).



Cold-Weather Building on Summer Schedules

YEAR-AROUND BUILDING has been talked about for a generation. The fact that this idea, though widely accepted, is not acted on more generally, suggests it may be more a matter of expense than of custom.

It costs money to heat concrete, supply heat protection, and space out construction schedules. Perhaps that is why attempts to 'educate' the construction industries have made so little progress. We may be wrong, but doesn't it seem logical that if you can reduce by 60% or 70% the cost of winter heating and protection; re-use forms in 2 or 3 days, instead of 2 or 3 weeks; minimize the hazards of sudden cold waves, and maintain summer schedules in cold weather—that more headway can be made in the next five years than in the past 25, toward a 12-month building year? The pocketbook is a lot more convincing than the text-book!

Read how 'Incor' Cement makes these savings possible—in a new, illustrated book entitled "Winter Construction." It isn't a lot of sales-promotion copy—it's full of helpful, down-to-earth suggestions. Write for a copy today.

'Incor'* is made and sold by producers of Lone Star Cement, subsidiaries of International Cement Corporation, New York; also sold by other leading cement manufacturers. *REG. U. S. PAT. OFF.

'INCOR' 24-Hour Cement

mum temperature. With the high-early-strength cement the maximum temperature attained both with and without calcium chloride was at or near the boiling point of water, so that the heat of hydration could not be ascertained satisfactorily since an undetermined portion of the heat was involved in the latent heat of vaporization of water.

Effect on Physical Properties of Mortars and Concretes

In order to obtain a measure of the effect of calcium chloride on the physical properties of the cements in mortars and concretes it was deemed advisable to control all factors, as far as possible, so that the admixture of calcium chloride would be the main variable.

Results. The average setting time, together with, in general, the spread of the time of set, decreases as the amount of calcium chloride is increased. Similarly the addition of calcium chloride to the white and high-early-strength cements shows the same effect as observed with the standard cements. All pats, both with and without calcium chloride, were sound.

The concretes with all percentages of calcium chloride show increased strength over the plain concrete at all ages tested. At one day the average strength of the concrete with 1.5 per cent admixture was 123 per cent higher than the average strength of the plain concrete. At 28 days the increase was 13 per cent, and at 90 days 9 per cent, indicating that calcium chloride has a greater accelerating action at early ages. There is very little advantage of adding more than 2 per cent commercial (1.5 per cent anhydrous) calcium chloride, the amount generally recommended for use at 70 deg. F. The strength of the concrete containing white cement was within the same range as for those with standard cements, and calcium chloride had apparently the same effect. The strength of the concrete made with high-early-strength cement was also increased by the addition of calcium chloride. However, the strengths were higher than those of the eight standard cements in all cases.

The effects of the addition of calcium chloride on the strengths of the cements when tested in 1:3 standard sand mortars showed the same trends as observed on the concrete strengths.

The tests of the strength at different curing temperatures have been undertaken to ascertain how strength of concrete may be affected by the addition of calcium chloride under the temperature conditions encountered during the construction season. Specimens have been made for two curing temperatures (70 and 90 deg. F.) and curing a group of specimens at a temperature of 40 deg. F. is being studied. Since this part of the investigation is not finished a tabulation of the results obtained to date will not be included in this report. It is of interest, however, to note here that the one day specimens without calcium chloride cured at 90 deg F. have approximately the same strength as the 70 deg. F. specimens containing calcium chloride.

During the molding of both the mortar and concrete specimens a greater ease of placing was noted when calcium chloride was incorporated in the mix. To obtain some measure of this phenomenon, flow measurements were made on the concrete. With each cement flows were increased by additions of calcium chloride to the concrete.

The flows of the concrete containing white cement were within the same range as for those with standard cement, and the calcium chloride had approximately the same effect. The flow of the concrete containing high-early-strength cement was similarly increased by the addition of calcium chloride, but the flow was smaller in all cases.

Summary

In considering the results obtained in this investigation, it should be borne in mind that the tests are by no means finished, and that later information may alter some of the following tentative conclusions:

1. Calcium chloride increases the rate of heat evolution of all cements included in the investigation.

2. Calcium chloride increases the total heat of hydration of low-heat cements, and may decrease the heat of hydration of high-heat cements at 24 hours.

3. The chemical composition of the cement has an important effect upon both the rate and total amount of heat of hydration developed during the first 24 hours. The general effect of calcium chloride over the range in composition studied was a tendency to level the heat of hydration to an average increase of about four calories per gram at 24 hours.

4. The times of set of 11 commercial cements were decreased by adding increasing amounts of calcium chloride. The greatest proportional decrease was obtained by the addition of 2 per cent commercial calcium chloride.

5. Additions of calcium chloride did not affect the soundness of the cements.

6. The addition of calcium chloride increased the strength of the concrete made from the cements tested at all ages to 90 days, beyond which results have not yet been obtained.

7. The flow of concrete was increased by the addition of calcium chloride.

Reduces Costs to Aid Housing

A DROP averaging 7 per cent in overhead sales and delivery cost on less-than-carload shipments of builders' supply materials has been authorized through an administrative order by the National Recovery Administrator. The order was requested by the Code Authority for the trade to aid the home-building and home-modernization program of President Roosevelt.

This drop in costs was brought about by application of the Code Authority to modify former administration-approved figures and percentages which constituted the minimum overhead cost of selling and delivering builders' supplies in less-than-carload quantities. This was done by eliminating items of interest and lost accounts (excepting a reserve for lost accounts of 1 per cent), and establishing specific modal percentage charges.

Materials Affected by Order

Materials affected by the order include cement and cement products, cement pipe, mesh reinforcement, metal lath and kindred products, mineral aggregates, mortar and cement colors, molding plasters, sewer pipe and waterproofing compounds.—From the September 4 issue of *The Blue Eagle.*

KEEP UP THE GOOD WORK

INSURE MIDSUMMER EFFICIENCY FOR COLD WEATHER CONCRETING

CONCRETE CURING WITH CALCIUM CHLORIDE IS SIMPLE:

(1) To a barrel one-third full of water, add one bag (100 lbs.) of flake Calcium Chloride. (2) Stir and then add enough water to half-fill the barrel (25 gals.), making sure that all the Calcium Chloride is in solution. (3) Add two quarts of this solution to each bag of cement in the mix — reducing mixing water accordingly.

WINTER construction is vital to unemployment relief. And now concreting need not be delayed and concrete quality need not be sacrificed through exposure, thanks to Calcium Chloride, the modern and widely accepted method of concrete curing.

Calcium Chloride used in-the-mix is worth many times its cost in giving summer strength to out-summer concrete. It more than doubles the early strength in the critical period. In cold weather it accelerates the hardening to afford positive protection against frost. And in freezing weather it greatly reduces the time and protective measures required to attain working strength. No other method offers the surety and economy made possible through Calcium Chloride curing.

For literature and complete information on Calcium Chloride concrete curing, write to any of the following members of the

CALCIUM CHLORIDE ASSOCIATION

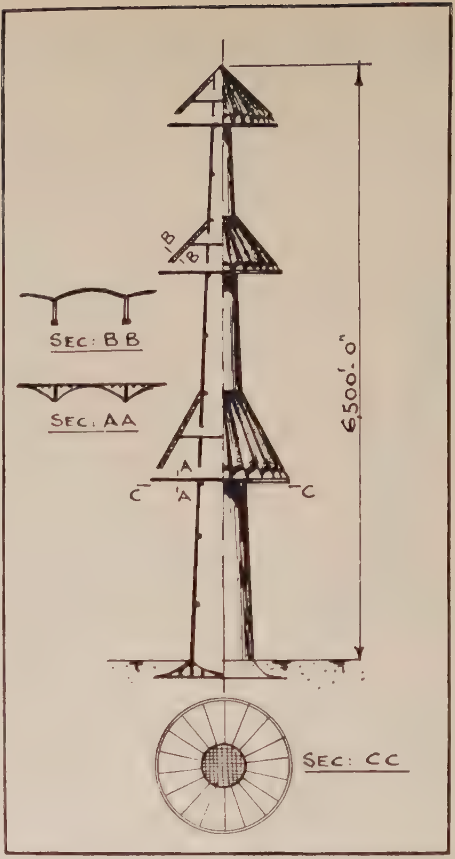
MICHIGAN ALKALI COMPANY . . 60 E. 42nd Street, New York City
SOLVAY SALES CORPORATION . . 61 Broadway, New York City
THE DOW CHEMICAL COMPANY . . . . . Midland, Michigan
THE COLUMBIA ALKALI CORPORATION . . . Barberton, Ohio

CALCIUM CHLORIDE

• FOR MODERN CONCRETE CURING •

Propose Reinforced Concrete Tower 6,500 Feet High *for* Paris Exposition

Designed for Aerial Defense of French Capital—Tower to Have Solid Exterior Wall—Covered Platforms to House Defending Guns and Airplanes



French engineer proposes reinforced concrete tower 6,500 ft. high, for the aerial defense of Paris

From *Ferro-Concrete*, August, 1934

IN the February (1934) issue of CONCRETE, page 24, reference is made to a high reinforced concrete tower proposed by the French engineer Freyssenet for the Universal Exposition to be held in Paris in 1937. The height proposed by Freyssenet is 2,300 ft.

A far more daring proposal has now come from another French engineer, Henri Lossier, who, in conjunction with M. Faure-Dujarric, architect, has designed a circular reinforced concrete tower of the solid-shell type 6,500 ft. high. Readers of CONCRETE are referred to an article on page 22 of our issue of April (1934) quoting from an article in *Ferro-Concrete* in which Lossier discusses the possible heights of reinforced concrete towers by several different types.

In addition to providing a spectacle for the 1937 Exposition, Lossier's tower is designed primarily for the aerial defense of Paris. It is realized, states an article in the August (1934) issue of *Concrete and Constructional Engineering* (London), that artillery fire from ground level is of little use against aerial bombers, and that defending airplanes are handicapped by the delays necessary before they get into action.

The article just mentioned states further that the tower is to have covered platforms at heights of 2,000 ft., 4,300 ft., and 6,000 ft. above ground level, which would be above the danger zone in a gas attack and could be used as runways for the defending machines and as platforms for artillery. In this way the defending machines would start from a level approximately the same as that of the attacking bombers, and the 100 4-in. guns on each platform would have a similar advantage in height. Lifts would be provided inside the tower, and anti-aircraft guns, searchlights, etc., would be fitted on the platforms. The site suggested for the tower is at Issy-les-Moulineaux, on the south of Paris.

The exterior diameter of the shaft of the tower in Lossier's design is 690 ft. at ground level and 130 ft. at the top. At the bottom the thickness of the tower wall is 39 ft.; this decreases towards the top, the shell being designed with uniform strength. The wall foundations are conical and 650 ft. wide, the two cones meeting at the center of the circular foundation and forming a slab with an overall diameter of 1,300 ft. Each horizontal platform overhangs the tower shell by 490 ft. and is covered by a sloping roof forming a truncated cone around the tower. At the lower platform the truncated cone has a height of 985 ft.; at the two other platforms the height is 656 ft. In the sloping roof, openings 100 ft. high and 165 ft. wide are made for the departing aeroplanes.

The calculations have been made with a wind pressure varying from 50 lb. per sq. ft. at ground level to 100 lb. per sq. ft. at the summit of the tower. A reduction of one-third was allowed to take account of the circular cross-section. The maximum shearing stress was 94,000 tons and the bending moment 297,000,000 foot-tons. The calculated overturning moment due to the recoil of the guns is only 6 per cent of that due to the wind.

To erect the tower, it is stated, moving steel forms would be used, and the concrete would be vibrated and, in parts, de-aerated.

Obituary

Walter Boynton, at one time owner and editor of Concrete-Cement Age—now CONCRETE—died following a heart attack at the new Willard Hotel, Washington, D. C., on September 23, at the age of 58. Mr. Boynton has been connected with advertising agencies much of the time since he left the business paper field. At one time he was chief of publicity for the Detroit office of the General Motors Corporation and later became Detroit editor of the Automotive Daily News, when that publication was started. He is survived by his widow, Mrs. Irene Goddard Boynton, and a daughter, Mrs. Sidney Corbett III.

BOOKS On Concrete

List No. 2—Design and Construction, Concrete Making, Cement Manufacture

(Prices quoted are for cash in advance, and include postage)

DESIGN AND CONSTRUCTION OF FORM WORK FOR CONCRETE STRUCTURES. By A. E. Wynn. 320 pages, 219 ills., 12 folded inserts and 11 design tables. Cloth bound, stamped title in gold. Price $6.00

"Wynn's Book" is a phrase commonly known to engineers, designers, and foremen, and is heard wherever concrete construction is under way. This book covers every phase of forms for concrete construction, and is fully supplemented with many illustrations, tables and drawings and printed on a superior grade of enameled paper.

CONCRETE CONSTRUCTION MADE EASY. By Leslie Turner and Albert Lakeman. 113 pages, 65 illustrations, 16 tables. Cloth bound. Price $2.00

A practical book that solves problems in the design and erection of any type of concrete structure. Full designs with tables and all necessary information for building of foundations, walls, columns, floors, roofs, staircases, beams, water tanks, retaining walls, lintels, formwork, saw-tooth roofs, etc. Written clearly and plainly.

BASIC PRINCIPLES OF CONCRETE MAKING. By Franklin R. McMillan, Director of Research, Portland Cement Association. Ninety-nine pages, 6x9½, 32 illustrations and tables. Price $2.00

The author has culled the essentials out of a mass of scientific data on this subject and presents them with force and directness in this book. He shows the effects of quality of material, of proportioning, mixing, working and curing on the finished concrete.

The importance of variable mixes; tests for permeability; how to obtain strength, durability and watertightness; effective ratios; importance of proper construction methods—these and many other vital topics are discussed fully and authoritatively.

GENERAL ENGINEERING HANDBOOK. By Charles Edward O'Rourke and 29 associates. Flexible cover; 921 pages, 5 by 8 in., numerous tables, diagrams, and illustrations. Price $4.00

A great amount of fundamental engineering data in usable form, 31 separate sections dealing with as many specific branches of engineering. Of particular interest to engineers who specialize in the use of concrete as a structural material are sections devoted to "Highways," by Thomas R. Agg; "Reinforced Concrete Structures," and "Stresses in Framed Structures," by Charles Edward O'Rourke; "Engineering Materials," by Herbert H. Scofield; "Foundations," by Roland P. Davis; and "Mechanics," by Alfred P. Poorman.

REINFORCED CONCRETE CONSTRUCTION. By George A. Hool, Professor of Structural Engineering, University of Wisconsin.

Vol. I—Fundamental Principles. Third Edition. 380 pages, 6x9, 139 illustrations, 18 tables, 28 diagrams $3.50

Vol. II—Retaining Walls and Buildings. Second Edition. 700 pages, 6x9, illustrated $6.00

Vol. III—Bridges and Culverts, 688 pages, 6x9, over 600 illustrations, 41 plates $6.00

ESTIMATING AND COST KEEPING FOR CONCRETE STRUCTURES. By A. E. Wynn. Published in 1930; 272 pages, 92 illustrations, 2 folders. Price $5.00

The author of this book has had a wide experience in contracting for all kinds of concrete structures, and in this volume he publishes his own simple methods of estimating, cost-keeping and book-keeping. Reproductions are given of all blank forms required.

CONCRETE ENGINEERS' HANDBOOK. By George A. Hool and Nathan C. Johnson, assisted by S. C. Hollister, and with chapters by Harvey Whipple, Adelbert P. Mills, Walter S. Edge, A. G. Hillberg and Leslie H. Allen. 800 pages, 6 x 9. Illus. Flexible binding. Price $6.00

A compact reference book, containing tables, formulae and data on plain and reinforced concrete, covering the entire field.

CEMENT CHEMISTRY IN THEORY AND PRACTICE. By Prof. Dr. Hans Kuhl, Director of the Institute for Cement Research, Berlin. Translated into English by J. W. Christelow, B.Sc. 64 pages, 6 by 9, cloth cover. Illustrated with a number of halftones and diagrams. Price $2.50

An authoritative book on the chemistry of cement, a translation of a series of lectures delivered by Dr. Kuhl in Moscow, at the **special request of the Soviet government.** The author presents the most up-to-date knowledge of the subject in simple language. The result is a concise record of modern research on the manufacture and setting of cement. Chapter headings are: (1.) The Development of Cement Research; (2.) The Theory of Cement Burning; (3.) The Constitution of Portland Cement Clinker; (4.) The Problem of Hardening and Its Significance in Cement Research; (5) The Chemistry of High-Strength Cements; and (6.) The Technical Aspect of High-Strength Cements.

PORTLAND CEMENT. By A. C. Davis, works managing director, Associated Portland Cement Manufacturers, Ltd. Published in 1934. Cloth, 435 pages, 6½ by 9½ in., 262 illustrations, 22 tables. Price $7.50

A new book on cement manufacture, covering more especially the present-day British and continental practices. The author discusses and analyzes such important problems as modern manufacturing methods and organization; formation and nature of cement raw materials; factors governing choice of materials and manufacturing processes; advantages of dry and wet processes; raw material and clinker-grinding problems; improving the efficiency of the rotary kiln; methods of coal feed, slurry drying, and kiln control; reactions in burning cement; rotary kiln heat balances; conservation of heat in rotary kilns; advantages of the purchase of electricitv compared with generation at the factory; modern methods of packing and shipping cement; production costs; mineralogy and chemistry of cement.

STANDARD CONSTRUCTION METHODS. By G. Underwood. 408 pages, 330 illustrations. Price $5.00

A complete, detailed presentation of actual methods used in practical construction work. A book packed from cover to cover with plans, short-cuts and expedients for construction superintendents and other men upon whom rests the responsibility of getting jobs done quickly and well.

REINFORCED CONCRETE AND MASONRY STRUCTURES. By Hool and Kinne. 722 pages, 6 x 9, illustrated. Price $6.00

The work of 14 specialists. This book offers a practical and detailed discussion of every important element entering into the design and construction of concrete and masonry structures. Particularly noteworthy are the very thorough treatments of Reinforced Concrete Buildings, Concrete Forms, Chimneys and Concrete Detailing.

HELPS TO SUCCESSFUL CONTRACTING. By Harry O. Locher. Published in 1934; 222 pages, 5½ by 8 in. Price $2.00

An unusual book for contractors, covering every phase of the work from estimating and bidding to cleaning up and moving to the next job. Written by an author with more than 30 years of experience in the contracting business. Every contractor and construction superintendent or foreman should have a copy.

WINTER CONSTRUCTION METHODS. By Charles S. Hill. Cloth, 180 pages, 6 by 9 in., illustrated. Price $3.00

This book assembles in one volume the practices found most effective in carrying on concrete construction work in cold weather. Subjects treated in individual chapters include construction of concrete bridges, roads and street pavements in winter; use of special cements in cold weather; heating of materials; handling and placing concrete; protectig concrete in heavy sections; progressive canvas housing for building construction; and use of complete enclosures.

SPECIAL COMBINATION OFFER: $1.50 (or $2.00 for Cement Mill Edition) added to the price of any of the above listed books will entitle you to one years subscription to Concrete or extend your present subscription one year from its present expiration date. Foreign and Canadian subscribers please write for details.

Book Department of CONCRETE, 400 West Madison Street, Chicago, Illinois

HOW TO DO IT

◆ Questions and Answers ◆
Consultation and Comment

A department devoted to the solution of problems encountered in concrete work. Readers are welcome to add to or improve upon the suggestions printed and to submit their views for possible publication.

Strength of Concrete Manhole Block

We are providing solid concrete manhole block for a sewer extension project in this city, and we have delivered some block that test from 1,600 to 1,800 lb. per sq. in. in crushing strength. The city authorities, however, are demanding a strength of 2,500 lb. per sq. in.

What crushing strength is usually specified for concrete manhole block by organizations such as the American Society for Testing Materials?—M. H. W., Ohio.

The strength demanded by your city authorities is far above the strength required in any standard specifications available. The American Society for Testing Materials has not as yet developed a specification for concrete manhole block, but the American Concrete Institute has done so. Paragraph (3) of the Institute's "Tentative Specifications for Concrete Manhole and Catch-Basin Block," serial designation P-1 C-27 T, contains the following strength requirements:

> The ultimate compressive strength of solid concrete manhole and catch-basin block, at 28 days of age or when delivered upon construction work, shall average not less than 1,500 lb. per sq. in. of cross-sectional area of the unit as laid in the wall. No individual unit shall test less than 1,200 lb. per sq. in. of cross-sectional area under the same conditions.

From the foregoing you will see that your city officials' demands are far in excess of what is regarded as ample by the leading technical society in the field of concrete construction.

It is suggested that you ask the American Concrete Institute, 7400 Second Blvd., Detroit, Mich., for a copy of their specification from which the above quotation is taken. You should also write to the Portland Cement Association, 33 W. Grand Ave., Chicago, for their data on this subject.

Cutting Concrete with Torches

Have any of the equipment manufacturers developed blow torches especially for use in cutting concrete? I have a problem where such a torch might be used, but I have never seen it done that way. Information on the subject will be appreciated.—F. G. M., Hammond, Ind.

The question of using torches in cutting concrete depends upon whether it is necessary to cut a definite line or whether the purpose is merely to break up the concrete. A torch can not be used successfully in cutting a definite line, because the application of this intense heat at the point to be cut is almost certain to cause cracking or spalling beyond the cut.

In cases where the only purpose is that of breaking up the concrete and where the question of cracking beyond the cut is not important, it is possible to use some of the larger torches successfully. Some types of torches burn as much as 2½ gallons of gasoline or kerosene per hour, and create an intense heat. Even in this case the use of these torches is dangerous, because of the probability that the molten concrete or slag will pop and sputter and injure the operator. The safest method is to set the torch at the point desired and then to remain at a safe distance while it is in operation.

The Automotive Age and the Railroads

About a year ago I saw a pamphlet, written by a newspaper man, in which the writer shows how the development of the automobile has helped the railroads in matters such as freight tonnage. Many useful statistics also were given. Can you tell me where to obtain this pamphlet?—A. S. R., Montgomery, Ala.

It is quite probable that the pamphlet to which you refer is a 16-page booklet entitled "The Automotive Age and the Railroads," by L. A. Rossman, publisher of the *Herald-Review*, Grand Rapids, Minn. Unless the supply is exhausted, copies of the booklet can be obtained from the National Highway Users Conference, National Press Building, Washington, D. C.

Producing Manhole Block

Can you refer me to manufacturers of special machinery for making concrete manhole blocks?—W. C. B., Worcester, Mass.

As a general thing, manhole blocks are made with special molds attached to the commonly used types of concrete block-making machines, the units being tamped or vibrated in the usual way. In consequence, we are referring your inquiry to manufacturers of block-making equipment.

An exception to the foregoing statement may be made in the case of a type of manhole unit made on the Pacific Coast. That unit consists of a complete circular ring, and special equipment is, of course, necessary in its manufacture.

Outdoor Fireplace

We have a request for plans and pictures of an outdoor fireplace suitable for backyard use, simple in construction and preferably with a chimney. Can you refer us to anything of this nature?—N. A. L., North Adams, Mass.

The Portland Cement Association, 33 W. Grand Ave., Chicago, can supply you a data sheet containing plans for an outdoor fireplace, as well as complete instructions for building it. Instructions given include the quantities of all materials required.

This material was prepared especially for the use of concrete contractors. Copies may be obtained, without charge, from the Portland Cement Association.

Concrete Pavements

(*Continued from page 8*)

and 1930 was 78 per cent, with a minimum of 47 per cent and a maximum of 97 per cent. The average efficiency of operation of key equipment on 10 projects studied between 1923 and 1928 was 55 per cent, with a minimum of 42 per cent and a maximum of 66 per cent. There appears to have been an increase in efficiency in recent years.

(5) The efficiency of operation of major equipment is a reasonably accurate measure of the efficiency with which the entire paving organization is operated. It is an indication of the type of supervision employed.

(6) Unnecessary interference by inspectors tends to lower operating efficiency and to discourage employment of adequate supervision.

(7) About 30 per cent of the total cost of a concrete pavement is for cement delivered to the project. Twenty-nine per cent is for aggregates delivered to the project. Thirty-seven per cent of the cost of cement and aggregates delivered is for transportation. The equipment cost is 9 per cent and the labor cost is 11 per cent of the total cost of a concrete pavement (exclusive of rough grading, etc.). The daily cost for labor and equipment is almost constant regardless of quantity of production. The unit cost for these two items varies almost inversely with the efficiency of operation.

(8) The cement factors used on the projects analyzed varied from 1.23 to 2.10 barrels of cement per cubic yard of concrete.

(9) The present method of combining the cement, aggregates, and water into concrete does not produce a homogeneous mass in which these ingredients are uniformly distributed throughout the mass.

(10) Present methods of placing and finishing the concrete require fairly wet mixtures, resulting in excess water, which decreases the potential strength of the concrete.

Coming Conventions

September 24-25—**Concrete Reinforcing Steel Institute. Semi-Annual. Westchester Country Club, Rye, N. Y. R. W. Johnson, Secy., 201 N. Wells Street, Chicago.**

October 1-5—**National Safety Congress, Portland Cement Association. Hotels Cleveland, Statler and Carter, Cleveland, Ohio. A. J. R. Curtis, 33 W. Grand Avenue, Chicago.**

December 6-7—**Highway Research Board, National Research Council. Fourteenth Annual Meeting. Roy W. Crum, Director, 2100 Constitution Avenue, Washington, D. C.**

1935

January 22-25—**American Road Builders' Association. Convention and Highway Exhibit. Willard Hotel, Washington, D. C. Chas. Upham, Engineer-Director, National Press Building, Washington, D. C.**

February 19-21—**American Concrete Institute. Thirty-First Annual Convention. Roosevelt Hotel, New York City. Harvey Whipple, Secretary, 7400 Second Blvd., Detroit, Mich.**

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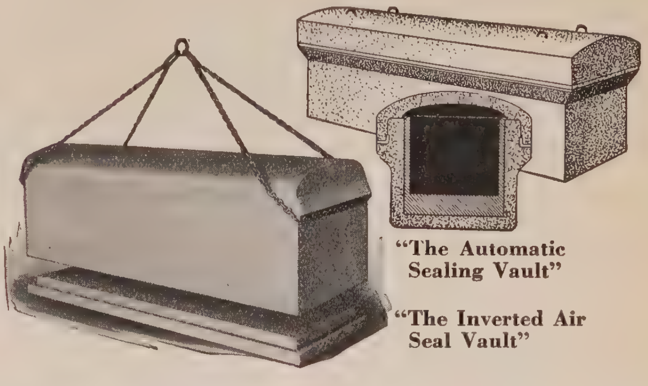

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New Books and Pamphlets

Highway Design and Construction

Highway Design and Construction. By Arthur G. Bruce, senior highway engineer, U. S. Bureau of Public Roads. Published by International Textbook Company, Scranton, Penna. Flexible binding, 628 pages, 5¼ by 8¼ in., extensively illustrated. Price $4.00.

In this volume the author, who has charge of the work of the U. S. Bureau of Public Roads in eight thickly populated eastern states, presents as briefly as possible, yet in clear and understandable form, the fundamental principles underlying this very important subject of highway engineering in accordance with the latest American practice. It is a complete engineering textbook, covering all types of roads and pavements, as well as administrative details, highway location, drainage, soil studies, and related subjects.

A chapter of 80 pages is devoted to portland cement concrete pavements, and a short chapter to cement-bound macadam. Indicative of the up-to-the-minute character of the contents is an extremely instructive chapter of 22 pages devoted to highway beautification and lighting. A bibliography is given at the end of each chapter.

Analysis of Continuous Frames

Analysis of Continuous Frames. By Earle B. Russell, consulting structural engineer. Published by Ellison & Russell, Pacific Building, San Francisco, Calif. Stiff paper binding, 73 pages, 6 by 8 in. Numerous tables and diagrams. Price $1.00.

The method employed is original with the author and is a practical method which can be used in an engineering office. The book treats frames for both vertical or transverse loads, and for members with uniform or variable moments of inertia. Tables are presented for members with variable moments of inertia which are quite complete. These tables may be used directly in the Hardy Cross method. Various types of problems are worked out.

There is also included a very useful set of tables for continuous beams of variable spans with different combinations of loaded spans.

Tests of Concrete Columns

An Investigation of Reinforced Concrete Columns, by Frank E. Richart and Rex L. Brown. Published as Bulletin No. 267 of the Engineering Experiment Station, University of Illinois, Urbana, Ill. Price $1.00, but a limited number of free copies are available.

This 94-page illustrated bulletin describes the elaborate series of tests and investigations conducted during the course of several years by the Engineering Experiment Station in co-operation with the American Concrete Institute. Similar tests were conducted simultaneously at Lehigh University.

Masonry Mortar

Masonry Mortar is the title of a new 36-page booklet issued by the National Lime Association, 927 Fifteenth St., N.W., Washington, D. C. Single copies are free.

In this booklet the advocates of lime mortar state their case, based on the results of co-operative tests conducted at the U. S. Bureau of Standards. When lime is to be used in combination with portland cement in masonry mortar, the booklet recommends the ratio of two parts of lime to one part of cement.

ORGANIZATIONS

American Association of State Highway Officials; W. C. Markham, Executive Secretary, 1222-24 National Press Building, Washington, D. C.

American Chemical Society, Mills Building, Washington, D. C.

American Concrete Institute; Harvey Whipple, Secretary, 7400 Second Blvd., Detroit, Mich.

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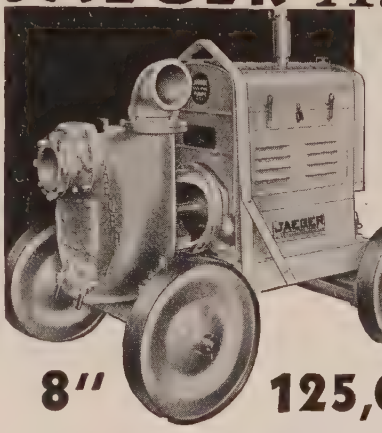

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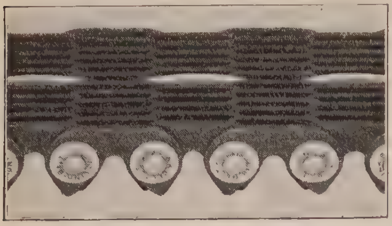
EQUIPMENT AND MATERIALS

SILVERSTREAK silent chain has been announced by Link-Belt Company, Indianapolis. In keeping with today's trend toward greater thought to the aesthetic in designing even the commonest machinery part, the maker has given a "new dress" to a 32-year old product, the Link-Belt silent chain drive, by bluing most of the chain, and treating the washers and guide bars to give them a silvered appearance. The bluing of the bulk of the chain has the effect of placing the silvery parts on a dark blue background, thereby emphasizing the silvery parts.

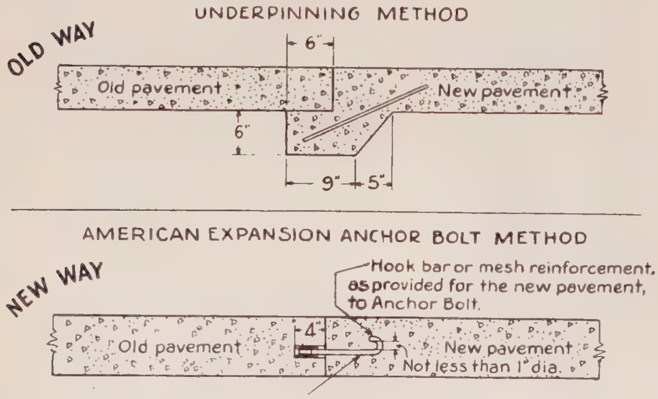


Link-Belt's Silverstreak silent Chain

It is made in all standard types, for both industrial first reduction drives and automobile silent timing; viz., side flanged, middle guide, no back bend, and duplex types.

Sliverstreak silent chain follows fairly closely on the heels of the announcement of Link-Belt Silverlink roller chain.

AMERICAN Expansion Hook Bolts are now offered for tying new concrete to old. The American Expansion Bolt & Mfg. Co., Chicago, claims their anchoring devices will give highway departments the same effect in tying new concrete to old that they provide for when tying new concrete to new. They say that with their hook bolts set in the edge of the old concrete it is not necessary to dig back under the old section or to pour the plug any thicker than the old road—that the bolts not only anchor the new concrete to the old, but, in addition, form a bond and prevent any sag whatsoever, thereby making it an integral part of the old. Catalog No. 7 lists various American Expansion anchoring devices.



UNDERPINNING METHOD
OLD WAY
6"
Old pavement
New pavement
6"
9"
5"
AMERICAN EXPANSION ANCHOR BOLT METHOD
NEW WAY
Hook bar or mesh reinforcement, as provided for the new pavement, to Anchor Bolt.
4"
Old pavement
New pavement
Not less than 1" dia.

Detail of American Expansion method of tying new concrete to old compared with the old underpinning method

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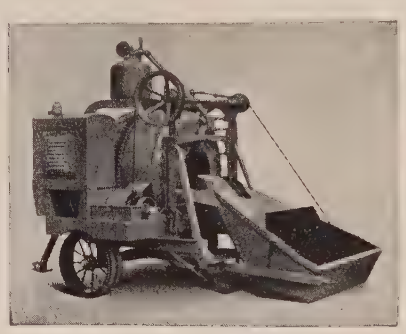
DANDIE Trail-Mix (10-S) is a new model recently announced by the Koehring Company of Milwaukee, Wisconsin, said to be similar in design to the four-wheel type 10-S Dandie mixer. The charging skip of this mixer is free from obstruction at the front and side, permitting convenient and fast loading. The machine has the Koehring automatic skip-flow shaker which actuates the skip up and down, causing shaking along the natural flow-line of the material. Anti-friction bearings, V-belt drive, automotive-type steering, and full-floating spring mounting are features of this new unit.



New Model Koehring mixer

SPEEDY construction equipment is offered by the Neptune Specialties Co. of Los Angeles. Speedy form ties grip, stretch and tie the wire on the outside of the forms with one quick operation, thus showing a very low labor cost, according to the makers. These ties, they say, stretch the wire straight through the forms and tie it securely on the outside, without twisting or "burning" the wire.

The Speedy wire puller is a tool, claimed by the makers to automatically grip wires at any point without slipping. In the smaller size, the tool is used for stretching plumbers' tape, strap iron or wire of any size, or for building and repairing wire fences.

Speedy adjustable screed supports consist of an ordinary lag bolt with a malleable cast yoke for holding the screed. The lag is screwed into the form to the proper depth, the screed is placed in the yoke and after the floor has been poured and leveled, the entire support is removed from the soft concrete and saved for reuse. It is easily adapted, they say, to use on the ground, a metal pan joist system, or for attachment to the I-beams of a steel frame building. Any length lag bolt may be used, they say, that will best meet the requirements of the job.

Manufacturers' News

Dry cement at Boulder Dam is conveyed from the upper to the lower mixing plant by means of this 3,500-ft. Lindewelded line of 9-in. pipe. At one point there is a drop of over a thousand feet. The smoothness and strength of the welded joints make this gravity system practicable, according to the Linde Air Products Company of New York City

Vol. XLII
No. 10

Cement Mill Section of
Concrete

OCTOBER
1934

Develop New Suspended Chain Process for Drying Slurry in Kiln

Several European Installations Follow Successful Test Runs of Three Years Ago—Slurry Fed to Kiln Through Jets—Large Savings in Fuel

THE slurry-drying process developed by the firm of Fellner and Ziegler rests on the following principle: "Dry the slurry in the kiln itself."

Suspended Chains Provide Large Surface

The means employed to this end consist essentially of a curtain of chains of special form suspended in the upper part of the kiln for a length of 50 to 65 ft., and a system of slurry feed comprising a number of jets that inject the slurry into the kiln. We have insisted from the very first on the fact that the arrangement of the Fellner and Ziegler curtain of chains differs completely from other arrangements utilized up to the present time in rotary kilns handling slurry. We have pointed out, as an essential difference, that the chains are arranged in the form of compact curtains, in the direction of the length of the kiln, parallel to each other, the strands fixed at one end only. The chains, during the rotation of the kiln, are suspended vertically in the upper part of the kiln while those in the lower part of the kiln rest on the refractory lining.

Jets Feed Slurry to Kiln

Against this wall of vertically suspended chains the slurry fed into the kiln is injected at an acute angle, in such a manner that because of the slow rotation of the kiln the wall of chains is hit from top to bottom by the injected slurry. The quantity of slurry, on the other hand, is regulated in such fashion that it controls the lowering of the temperature of the gas of combustion, as well as the point to which the temperature is raised in the hottest zone of the kiln. It follows that in this way there is obtained a judicious distribution of slurry over the extensive surface of the chains. The principle which the designers have followed in this arrangement has been proved practicable. The mass of chains, with their large surface of contact, form a perfect transmitter of heat between the gases of combustion and the wet slurry. We have commented on the fact that in a kiln with an inside diameter of around 6½ ft. the contact surface of the chains is nearly three times greater than the interior surface of the kiln lining in the length occupied by the chains.

Tests Show Large Saving in Fuel

Some tests were conducted with this arrangement for drying slurry, about three years ago, in a rotary kiln having a length of 148 ft. and an interior diameter of 6½ ft. at the higher end. Prior to those tests this kiln had a capacity of around 85 metric tons of clinker in 24 hours, with a heat consumption of 2,060 calories per kilogram of clinker. The kiln was supplied provisionally with an arrangement of chains according to the requirements of the new system; and as a result its capacity was immediately increased to 125 metric tons of clinker per 24 hours, with a heat consumption of only 1,650 calories per kilogram of clinker. We wish to state here that the quantity of water in the slurry was as high as 44 per cent (by weight), and that the result mentioned above was maintained over a period of four months—that is to say, until the test proved the method to be practical.

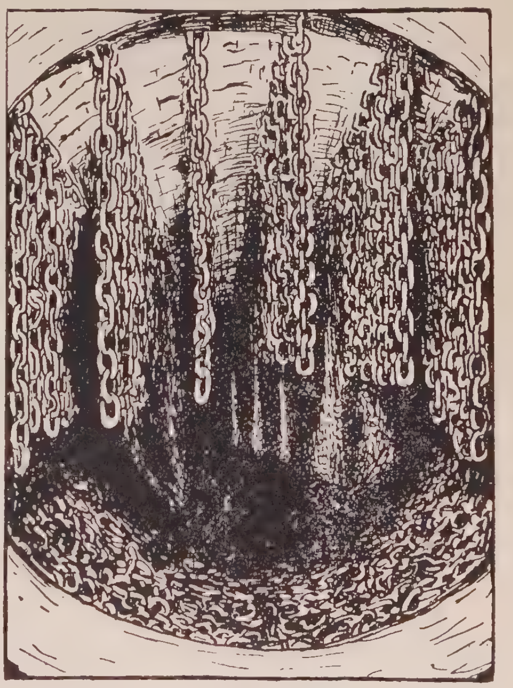


Figure 1. Cross-sectional view of kiln, showing arrangement of suspended chains

Exit Temperature of Kiln Gas Reduced

The exit temperature of the kiln gas was reduced from 410 deg. C. (770 deg. F.) to 235 deg. C. (455 deg. F.).

Translated from *Revue des Materiaux de Construction* (Paris), June, 1934.

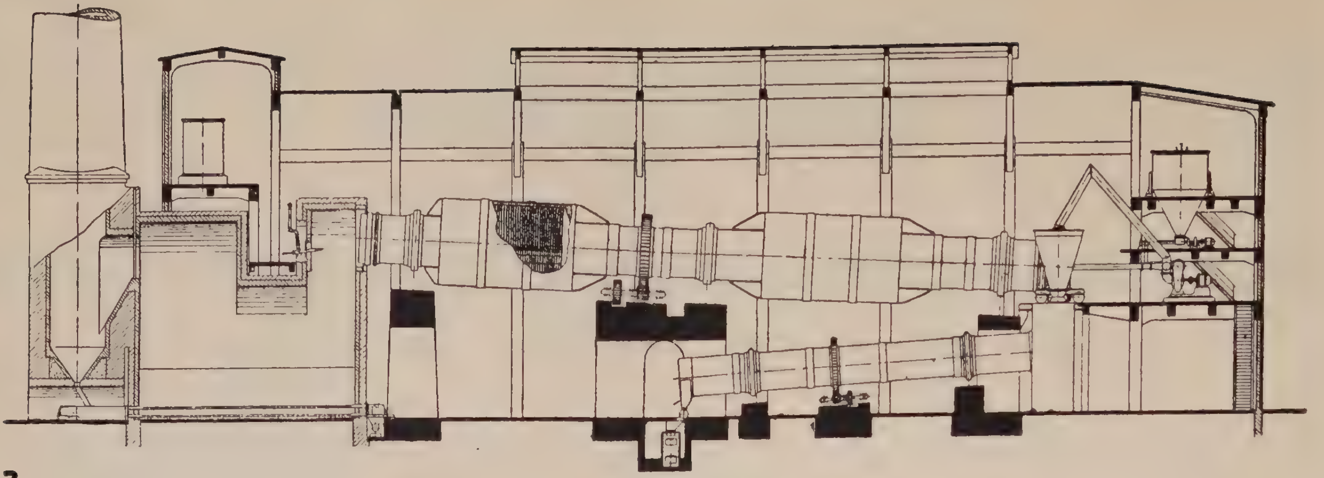


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Figure 2. Kiln with double enlarged zones, now under construction, will contain suspended chains in one of enlarged sections

That, however, was only the first result. In due time we were able to reduce the temperature of the kiln exit gas almost at will, with this system of drying slurry. Nevertheless, we fixed the temperature of the kiln exit gas at 200 deg. C. (392 deg. F.). In each particular case this temperature of the kiln exit gas had to be chosen without reference to an arrangement assuring a supplementary artificial draft of air.

It is worth mentioning also that with this system of drying the danger of the formation of annular rings of slurry in the kiln is absolutely non-existent.

Other Installations Follow Test Run

Later, three other rotary kilns were altered with the view of applying this drying arrangement, and they gave still better results, thanks to various improvements in the arrangement of the chains.

These results were so satisfactory that, when we found a kiln undergoing reconstruction in a cement mill in the northern part of France—a kiln 8 ft. 2½ in. in diameter and 197 ft. long—we did not hesitate to give a guarantee of 1,400 calories per kilogram of clinker (equivalent to about 950,000 B.t.u. per barrel) for a water content in the slurry of 38 per cent (by weight). Permission can be obtained, for cement men interested in this subject, to visit the installations described above. The kiln last described was operated only intermittently. Another kiln in another cement manufacturing plant in northern France—a kiln having a diameter of 8 ft. 2½ in. and a length of 197 ft., with its zone of calcination enlarged to 14 ft. 9 in. in diameter, is likewise having this drying system installed at the present time and will be ready for operation in about one month.

Less Dust in Kiln Gases

An important characteristic of this drying system is that the loss of draft, by comparison with a kiln not supplied with any system for the separation of the slurry, is scarcely higher.

In addition, it is equally interesting to observe that, notwithstanding the very slight diminution in the draft, the quantity of dust carried by the gas of combustion is very small. Exact measurements justify the estimate that the loss of dust is less than 2 per cent of the material entering the kiln.

Verifications obtained from actual practice show that the size of the clinker is more regular, about the size of a hazel nut.

Kiln with Double Enlarged Zones

At the present time we are constructing a kiln with double enlarged zones (Figure 2). The first enlarged zone is the zone of calcination. The second enlarged zone is that which will contain the greater part of the suspended chains. This conformation will permit the attainment of the utmost economy, thanks to a kiln extraordinarily shortened, which assures an output equal to that of a kiln 50 per cent longer but not possessing these enlarged sections.

For an installation of this type, we guarantee a consumption of fuel not in excess of that corresponding to 1,400 to 1,500 calories per kilogram of clinker (950,000 to 1,040,000 B.t.u. per barrel), depending on the percentage of water in the slurry and the burning characteristics of the raw material. It is supposed, however, that the temperature of the exit gas and the controller of the CO_2 of the gas will assure constant and exact control of the operation of the kiln.

It is hoped that the short description here given will encourage the study of the possibilities in altering existing rotary kilns. Such alterations are, moreover, nearly always easy to execute, and they do not involve prohibitive expense.

Acknowledgment. The slurry-drying process here described and illustrated has been developed by the firm of Fellner and Ziegler, A. G., of Frankfurt, Germany.

Puzzolanic Cements and Sea Water—Author's Name Omitted

It is to be regretted that in printing the translation of an article in *Cemento* (Barcelona) by Dr. Jose-Igual Ruiz, which appeared in our August (1934) issue under the heading "Puzzolanic Cements Offer Resistance to Sulphates of Magnesia," the author's name was omitted.

Dr. Jose-Igual Ruiz is director of the laboratory of the port of Valencia, Spain. He has conducted extensive investigations of the effect of sea water on cement and concrete, and is regarded as an authority on the subject.

New Automatic Bin-Level Indicator Has Many Operating Uses

Controls Feed to Packing Machines and Level of Cement in Hoppers—Signals Over-Feed Conditions in Screw Conveyors and Elevator Boots

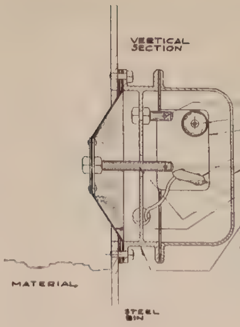


Figure 1. Cross-section detail of automatic bin-level indicator

A PRACTICAL bin-level indicator, having a number of useful applications in cement manufacturing plants, recently has been placed on the market, although for more than three years no less than 100 units have been in service in the plants of a large cement manufacturing company.

Final Result of Many Experiments

In its present form this automatically operated bin-level indicator represents the result of some years of experimentation by the cement manufacturing company just referred to. During this experimental period this company built and tried out a number of different types, in the effort to develop a device that would be thoroughly reliable, which would require no maintenance, and which could be built at a reasonable cost. The final steps in this development were completed early in 1931, at which time 100 units were built and installed in the several plants of the cement company.

Wide Range of Uses

These original 100 units, therefore, have been in use for more than three years. The plant management regards them as indispensable to efficient operation. The wide range of use to which this device may be put in cement plant operations may be realized from the fact that the installations in these plants include —

(1) High and low-level indications on the hoppers over the packing machines.

(2) Automatic control of the feed to the packing machines.

(3) Indication of over-feed conditions in screw conveyors.

(4) Indication of over-feed conditions in the boots of elevators.

Figure 2 (left) shows bin-level indicator on side of hopper over packing machine. Figure 3 (right) shows horizontal mounting on screw conveyor

From the foregoing it will be seen that this automatic bin-level indicator has developed its commendable performance record through a wide variety of practical applications.

Principal Mechanical Features

The operating mechanism of this device consists of a dust-tight canvas diaphragm which actuates a counter-weighted lever, which in turn operates a single-pole mercury switch. When the material in a bin, hopper, screw conveyor, or elevator boot, exerts a pressure at the point where the level-indicator is mounted, the diaphragm moves outward and operates the mercury switch. This lights a bulb at the control board, which is placed in a location where it may readily be seen. When the pressure is relieved, the counterweight forces the diaphragm back to its normal position, reversing the operation of the mercury switch.

The dust-tight canvas diaphragm is 8 in. in diameter. The counterweight on the lever which is actuated by the diaphragm is adjustable, to meet the requirements of different materials.

A cross-section detail of the device is shown in Figure 1. From this it will be seen that there are no springs in the device, and there is nothing that requires lubrication. Mounting of the installation is relatively simple, involving the cutting of a hole in the bin wall 8 in. in diameter, and the drilling of six bolt holes.

Controlling Feed to Packing Machine

Two of these devices have been installed, one above the other, in the hopper over the packing machine at the Oswego (N. Y.) plant of the Huron Portland Cement Co. Operating in conjunction with a rotary-type feeder, the devices provide automatic control of the feed to the packing machine, through electrical connections that hook them up with the motor that drives the packing machine feeder. Assuming the hopper to be nearly full to start with, and the feed motor shut off, the operator starts the packer and sacks the cement. When the surface of the cement in the hopper drops to the level of the lower indicator the pressure on the diaphragm is, of course, released. The counterweight forces the diaphragm back to its normal position, and the resulting action of the mercury switch automatically starts the motor that operates the feeder. As soon as the hopper is filled to the level of the upper indicator, the resulting action on the diaphragm of that indicator automatically shuts off the motor. Thus the quantity of cement in the hopper is automatically maintained between two pre-determined levels without requiring any attention on the part of the operator. This arrangement not only saves time and labor in filling the packer hoppers, but by maintaining a comparatively uniform level of the cement in the hoppers it reduces the fluctuations in weight of the sacked material.

The Toledo plant of the same company has a similar installation, the upper indicator installed near the top of the hopper over the packing machine being shown in Figure 2.

Keeping Watch on Screw Conveyor

Figure 3 shows another installation at the Toledo cement plant, this one being a horizontal mounting on a screw conveyor in the basement of the building. By means of electrical connections similar to those previously described, it signals to the operator on the third floor when the feed to this screw conveyor is too heavy. The operator can then reduce the feed by shutting off some of the feeders, which are electrically-controlled from the third floor.

At this plant cement is conveyed from the storage silos to the packer tanks by screw conveyors and elevators. Because of the installations just described, and by the use of rotary feeders, the entire operation and control of the conveying system is performed by one man on the third floor.

Acknowledgments. The bin-level indicator here described and illustrated is known by the trade name of "Bin-Dicator," and is manufactured by the Ripley Manufacturing Co., of Wayne, Mich.

The Distressing Excess Cement Capacity

By JOSEPH STAGG LAWRENCE

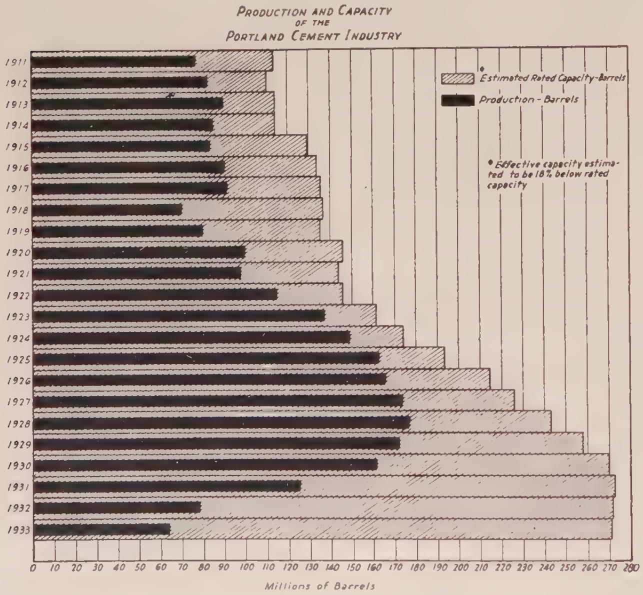
(In New York American, Aug. 12, 1934)

THE accompanying chart shows the annual output of cement from 1911 to 1934, represented by the solid black bars and the capacity of cement plants to produce, represented by the shaded background bars.

The growth of the cement industry shows roughly three stages. The first is a period of very rapid growth culminating, between 1909 to 1913, in a large excess of capacity. During the first decade of the twentieth century the use of portland cement increased enormously and rapidly displaced the natural cement used previously.

Profits were excellent, and as a result new plants were erected in rapid succession. Nineteen hundred and nine shows an addition of five new plants, 1910 shows nine and 1911 nine more. The incentive of profit was so great that capacity outran production, with the result that prices broke and many of the plants failed—no less than thirty-two being thrown into receivership.

Before the industry had an opportunity to recover from this set-back, the war occurred. With high prices, and the concentration of attention upon the prosecution of war, demand for cement lagged, and the condition of excess capacity was aggravated.



CEMENT PLANT CAPACITY, PRODUCTION AND SHIPMENTS FOR THE PAST 23 YEARS

	*Estimated rated capacity barrels	No. of Plants	Production, barrels	Per cent of Capacity Utilized	Shipments, barrels
1933	271,300,000	166	63,373,000	23.6	64,086,000
1932	271,308,000	166	76,740,945	28.3	80,843,187
1931	271,850,000	165	125,429,071	46.1	127,150,534
1930	270,044,000	166	161,197,228	59.7	159,059,334
1929	258,917,000	166	170,646,036	65.9	169,868,322
1928	243,702,000	156	176,298,846	72.3	175,838,332
1927	227,080,000	153	173,206,513	73.9	171,864,728
1926	215,300,000	140	164,530,170	76.4	162,187,090
1925	193,558,000	138	161,658,901	83.5	157,295,212
1924	175,100,000	132	149,358,109	85.3	146,047,549
1923	161,858,000	126	137,460,238	84.9	135,912,118
1922	146,203,000	118	114,789,984	78.5	117,701,216
1921	144,354,000	115	98,842,049	68.5	95,507,147
1920	146,400,000	117	100,023,245	68.3	96,311,719
1919	134,092.700	111	80,777.935	60.2	85.612.899
1918	137,601,200	114	71,081.663	51.7	70,915.508
1917	136,750,300	117	92,814,202	67.9	90.703.474
1916	133,679,650	113	91,521,198	68.5	94,552,296
1915	129,800,000	106	85,914,907	66.2	86,891,681
1914	115,000,000	110	88,230,170	76.7	86,437,956
1913	115,000,000	113	92,097,131	80.1	88,689,377
1912	110,000,000	110	82,438.096	74.9	85,012,556
1911	112,500,000	115	78,528.637	69.8	75,547,829

*Effective capacity estimated to be 18 per cent below rated capacity.

The next stage appears after the conclusion of the war. The building boom created a strong demand for cement, with the result that consumption was stepping upon the heels of output. Every available plant was called into operation. Higher prices stimulated the construction of new capacity, so that in 1923 eight new plants were built, in 1924, six, and in the next year, six again.

Unfortunately, this prosperity was more than the industry could stand. The promoters were over-confident regarding the future demand for cement, with the result that no attention was given to the flattening curve of demand, evident after 1925. Additions to plant capacity continued down to and including 1930, even though the demand for cement started to fall off in 1929.

With the sharp decline in construction that actually preceded the turn in the stock market, the cement industry is now afflicted with an extraordinary and burdensome excess of capacity.

"Grindability" and Actual Pulverizer Performance

New Laboratory Methods Determine Probable Performance with Large Pulverizers—Former Disagreement Due to Lack of Common Basis of Comparison

By **MARTIN FRISCH** and **G. C. HOLDER**
Foster-Wheeler Corporation, New York, N. Y.

ENGINEERS who find it necessary to do so now classify coals as to their softness or pulverizability, and in a general way as to the ease with which they may be burned in pulverized form. The required fineness as determined by combustion requirements and the pulverizability of the coal mainly determine the type and size of pulverizer most suitable. Many have realized the need for some simple test which could be carried out in a laboratory in order to reveal and measure some property of a coal which could serve as the basis for predicting the performance of large pulverizers with that coal. Several such test methods have been proposed, and many of these are now in the course of development. The most noteworthy and excellent are those proposed by Cross and Hardgrove.

Definition of Grindability

"Grindability" is now generally defined on the basis of Hardgrove's work to be the ratio of surface produced during the treatment of a small representative sample of a coal for a definite time in a special laboratory "grindability" machine to the surface produced with a standard or 100 per cent "grindability" coal treated in identical fashion. In order to make quantitative predictions as to how pulverizers will treat a stated coal, it is necessary to establish by test the relation between the capacity of each pulverizer and coals of different "grindabilities." One has but to examine the definition of "grindability" and the meaning of pulverizer "capacity" to understand that the relation between capacity and "grindability" for one type of pulverizer need not be the same for one as for another, or even for all sizes of the same type. If the capacity of a pulverizer were defined as the amount of particle surface produced per hour, then "grindability" as defined by Hardgrove might be considered as directly deducible from Rittinger's law. But since the capacity of a pulverizer is nearly always stated to be a rate of so many weight units per unit time at a certain stated fineness, pulverizers which presumably have exactly the same capacity according to the usual definition would not have the same capacity on the basis of particle surface output, unless the particle surface per unit weight of coal at a stated fineness is the same for all coals.

Much Difference in Fuels

As shown by a figure based on Sherman's careful microscopic size analyses of samples of a very soft coal, a hard coal, and one of semi-coke pulverized to various finenesses, the specific surface at any stated fineness is quite different for each of the pulverized fuels. A direct comparison, therefore, between the surface per unit weight of a stated coal and the standard coal after a "grindability" test of each will not give the same ratio as the ratio between the capacity obtainable with the coal and a standard coal pulverized to the same fineness unless in the "grindability" tests the stated and the standard coals were pulverized to the same fineness instead of for the same length of time. It may be shown that the relation between the capacity C_n obtainable in a stated pulverizer with a given coal to the capacity C_s obtainable with standard coal pulverized to the same fineness is proportional not to the ratio of the "grindabilities" of these two coals, but to a function which may be written as $C_n/C_s = (P)\ G_n\ (S/S_n)$, where G_n is the "grindability" of the stated coal in terms of the "grindability" of the standard coal taken as 1 and S/S_n is the ratio of the surface per pound of the stated coal to that of the standard coal when pulverized to the same fineness. P is a function depending on the relation between the characteristics of the commercial pulverizer and the "grindability" laboratory test mill.

Reducing Tests to Common Basis

An apparent lack of consistency between actual pulverizer tests and laboratory "grindability" determinations led to a study of the relationships between laboratory "grindability" test results and actual pulverizer test data, in order to determine whether the two could be reconciled. "Grindability" tests were made both by a method based on recommendations of Cross, later simplified, and by the Hardgrove method. The results of a large number of ball and roller pulverizer tests were completely analyzed by statistical methods and made comparable with each other and with the laboratory tests by reducing them to a common basis. Results of impact-mill tests were not included in this study. In order to make the various tests comparable they were reduced to a common basis by correcting for the effect of variations in fineness, feed size, and moisture from the standard. When so corrected, laboratory "grindability" tests with actual field tests of ball mills can be shown to vary consistently with each other, but not in direct proportion. The relation between "grindability" and capacity of a vertical ball and a roller mill is shown. The influence of feed size has been found to be important only when the feed contained a large proportion of fines. The increase in capacity to be expected from a decrease in feed size is roughly proportional to the ratio between the excess in particle surface represented by the actual feed over that in the standard feed as compared with the total particle surface represented by the finished product.

Abstract of paper for the American Society of Mechanical Engineers, 29 West 39th Street, New York, N. Y.

Studies Reactions Between High Alumina Cement and Mixing Water

Investigator Determines Effect of Various Proportions of Water—Two Cements Examined, One High and One Low in Iron Content

IN an article in *Zement*, in No. 22 of the 1933 issues, G. Assarsson gives the results of the study of the reaction between high alumina cement and water. His investigations included a study of the setting of high alumina cement by examining the changes in concentration of the liquid phase, and by microscopical study. The effects of various proportions of mixing water were also examined.

The Cements Examined

Two cements were used, one with a low and the other with a high iron content, and the results obtained were checked by experiments with pure cement compounds. The changes in the alumina concentration of the liquid phase show that the hydration of commercial cements depends upon two series of reactions. One, the primary, is based upon the solution of the calcium aluminates and the subsequent decomposition of the solution by crystallization and hydrolysis. The other consists in a slow solution of the small quantities of alkalies which occur in the cement. This secondary reaction depends to a marked extent upon the quantity of water present; it is very conspicuous with the small quantities of water used in practice, but, with large quantities, this reaction is indistinguishable from the primary reaction. The changes in lime concentration show no discontinuity and are solely governed by the quantity of mixing water. If this is increased, the alumina concentration diminishes and the lime concentration increases.

Effect of Large Quantity of Water

The molecular ratio $Al_2O_3:CaO$ is about unity during the first hours of the reaction and thereafter decreases steadily if the quantity of mixing water is not too great. Very large quantities of water produce a steady rise in the molecular ratio of the solutions. With normal quantities of mixing water, the hydration product is a gel formed by the hydration of the anhydro-monocalcium aluminate, a mono-aluminate gel ($CaO.Al_2O_3.10H_2O$), and dicalcium aluminate ($2CaO.Al_2O_3.8H_2O$). Pentacalcium aluminate ($5CaO.Al_2O_3.34H_2O$) and sulphoaluminates of various SO_3-content can occasionally be observed. With large quantities of water aluminum hydroxide, tricalcium aluminate ($3CaO.Al_2O_312.5H_2O$?) and two other hexagonal aluminates are also found; the last two can be distinguished by their refractive indices.

When the pure aluminates present in the clinker are gauged with water, solutions are obtained in which the changes in concentration correspond to the primary concentration curve of the cements, but the molecular ratio $Al_2O_3:CaO$ is very nearly unity if the amount of water is not too great. When the pure clinker components are hydrated, the principle constituents of the hydrated cement are found. A relationship has been established between the properties of the pure calcium aluminate solutions and those of the solutions and components of the commercial cement. Light is thrown upon the properties of mixtures of portland and high alumina cements, and the crystallization diagrams of the calcium aluminate solutions provide an explanation of the rapid setting of such mixtures. When mixtures of these cements are gauged, films of liquid which crystallize and coagulate rapidly are formed about the clinker particles and these are indicated by a certain field in the crystallization diagrams of the calcium aluminate solutions. In this connection the hydration of portland cement is discussed. The small quantities of alkali in the clinker are only gradually dissolved by the mixing water during the process of hydration.

Small Quantities of Water

When small quantities of water are used, the alkali content can become so great during the first three hours that its significance must be taken into account in the interpretation of the results. If only the alumina and lime contents are considered, the solutions are represented by a region of instability in the crystallization diagrams $Al_2O_3:CaO:H_2O$. The final solutions must be looked upon as mixed calcium and alkali aluminate solutions. The gels obtained from the cements and from the calcium aluminate were examined by the X-ray method. Three stages of gel formation were observed. The first is a gel that can be observed during the first hour, particularly in the hydration of the anhydro-mono-aluminate. The second is the hydrated mono-aluminate gel $CaO.Al_2O_3.10H_2O$, while the third is characterized by the formation of aluminum hydroxide. The gel in the first stage is of the greatest importance in the set cement. It is not only quantitatively the predominant product of hydration, but probably also responsible for the hardening of the cement.—*Building Science Abstracts.*

From the Patent Office

High alumina type cementitious material: N. V. S. Knibbs, Longfield, England. U. S. Pat. 1,966,864.—The process of producing hydraulic cements of the high alumina type from bauxite and other materials consisting essentially of free alumina comprises subjecting a mixture of such material and lime to the action of steam under a pressure greater than atmospheric pressure whereby hydrated calcium aluminates are formed, subjecting the product thus obtained to heat treatment at a temperature sufficient to drive off the combined water, and to the action of carbon-dioxide until any free lime present and substantially one-third of the lime in combination with alumina is converted into calcium carbonate.

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Cement making process: E. J. Maust, New York, N. Y. U. S. Pat. 1,963,588.—The process of making cement which comprises grinding the raw materials to a predetermined discharge fineness in the presence of water, hydraulically removing the finer portion and regrinding the coarser, the amount of water present during grinding being not more than that necessary to produce optimum viscosity at the given fineness of discharge and less than that required for hydraulically removing the finer particles.

EDITORIAL

Modern Utilization of Clinker Heat

THE amount of heat carried out of a kiln by white-hot clinker—in ordinary cases where the heat is not recuperated before the clinker leaves the kiln—is equivalent to about 5 lb. of coal for every 100 lb. of clinker.

The most practical use thus far developed for this heat, released when clinker cools off, is that of pre-heating the secondary air of combustion. One highly efficient American development of this character is described in an illustrated article in the March (1933) issue of the Cement Mill Edition of "Concrete," pages 35 to 40. In that system the clinker cooler is detached from the kiln, and only a part of the heat released by the clinker is returned to the kiln—an amount sufficient to pre-heat the secondary air of combustion to the desired temperature. The remaining heat is available for other purposes.

Another highly successful American type, originally developed for installation in separate clinker coolers, later was designed to be installed in the lower end of the kiln itself. This type, described in the July (1934) issue of the Cement Mill Edition of "Concrete," is now referred to as a heat recuperator rather than a clinker cooler as this latter term is commonly understood. It discharges the clinker at a temperature well above that required for grinding. The clinker temperature is, however, reduced from around 2,100 deg. F. to 750 or 800 deg. F., and practically all the heat thus given off by the clinker remains in the kiln and is utilized to pre-heat the secondary air that supports combustion.

The utilization of heat formerly wasted is reflected in a very substantial saving in fuel. The more rapid cooling of the clinker improves its grindability and increases the strength of the finished cement. These are characteristic results of all the modern clinker coolers developed.

It is, therefore, not surprising that designers of cement-making equipment have given so much attention to the recovery and utilization of clinker heat. The surprising thing is that cement manufacturers are so slow in accepting and installing these modern improvements.

Cement Shipments Maintained

CEMENT shipments, somewhat disappointing in June and July, again turned upward in August, showing a moderate increase over July shipments and an increase of more than two million barrels over August of last year.

While the rapid upward climb of shipments was halted in the month of May—somewhat earlier than usual—cement manufacturers can get some encouragement from the fact that shipments have not yet declined. Further encouragement comes from the fact that August awards of construction contracts were above the July figures, and that this increase came in the non-residential fields of construction.

Losing the Advantages of Improved Kilns

THE system of suspended chains in rotary kilns in wet-process plants, described in an article in this issue as a means of drying slurry in the kiln itself, utilizes some new principles; but in general, the use of chains for this purpose is not new.

Systems developed by other well-known equipment manufacturers have shown results closely parallel to the results reported in the article now presented.

Chains are installed in a special arrangement throughout the higher portion (or drying zone) of kilns that are not connected to waste heat boilers, so that the chains are evenly distributed throughout the cross-sectional area of the kiln, but do not hinder the passage of the material through the kiln.

Chains act in two ways toward increasing the transfer of heat from the kiln gases to the slurry. This transfer is accomplished, first, by the fact that the slurry forms a layer coating the surfaces of the chains, whereby a large increase in heat-transferring surface is obtained; and second, by the fact that the chains, while hanging in the upper part of the kiln during its rotation, absorb heat from the kiln gases which is given off as the chains are again immersed in the colder layer of slurry.

The use of enlarged zones in rotary kilns, shown in one of the illustrations in the article appearing in this issue, likewise may be described as something that is not new. Kilns with enlarged zones—one the drying zone and the other the burning zone—have been in operation for some years, with resulting advantages that are well known.

Practically all of these and other notable improvements in rotary kilns, however, have been developed in the past ten years. The older, straight rotary kiln of uniform diameter throughout its length, simple in construction and in operation, was employed for twenty years or more after the introduction of the rotary kiln to the cement industry. This period was followed by a period of moderate improvement, and finally by the distinct developments of the past decade.

From all this it is evident that cement manufacturers who continue operations with old unimproved kiln types are throwing money to the winds.

American Chemical Society Meets at Cleveland

Great Enthusiasm Prevails at Largely Attended Sessions—Members and Guests Buy 2,500 Season Tickets for Period of Convention

THERE were 2,500 paid admissions at the eighty-eighth meeting of the American Chemical Society—that is, 2,500 season tickets were sold for the five days of the convention. The Hotel Cleveland was too small adequately to accommodate the throng, which at times filled the large ballroom and overflowed into the corridors. In the crowd were students, professors, scientists, engineers, industrialists—who knew something about chemistry and wanted to know more, and who realized that chemistry is the basis of life itself and is involved directly or indirectly in all life's activities. So might a sports writer describe one of the most important scientific events of the year, and without the least exaggeration.

No Halt to Advance of Chemistry

Cleveland was an excellent host and seemed to sense the importance of the chemical industry even more than some other cities at which conventions have been held. In addition to the usual welcome and greeting posters, banks and stores displayed placards bearing such inscriptions as "Without Research, All Industry Would Stagnate." There were show window displays demonstrating the chemical composition of metals, fabrics, synthetic resins, and other materials.

At the first general session, Robert E. Swain of Stanford University presented some imposing figures showing that chemistry has made a greater advance during 1929-1933 than in any other five-year period, at a time when progress in general has been so adversely affected by business conditions. At the same session very interesting papers were presented on "Constants of carbon at arc temperatures" and "The technique of making large telescope mirrors." The latter was really more in the field of physics and engineering than chemistry.

Of Interest to Cement Men

The technical cement man could find much of interest in a variety of papers in which portland cement itself was not mentioned. Many of these were in the divisions of Physical and Inorganic Chemistry, Industrial and Engineering Chemistry, and Gas and Fuel Chemistry, although there were a number scattered through other sections. If he happened to be interested in the burning of gas in kilns and dryers, he could have spent a very profitable afternoon visiting the American Gas Association laboratories, where investigations involving combustion, insulation, temperature measurements, and gas appliances of all sorts were in progress.

The meeting demonstrated once again the intimate relation of science, technology and all industry. One can not be well informed in his own branch of industry without knowing something about what is going on in the other branches, and in science and technology in general.

Low Production of Special Cements in 1933

TO supply the mineral industry promptly with data on special cement production and markets during the past year, the following advance summary of information is furnished by the United States Bureau of Mines:

Preliminary figures on output of special cements in the United States in 1933 as reported by producers to the Bureau of Mines show the following:

High-early-strength portland cement produced in the United States in 1933, as reported by producers, amounted to approximately 1,072,000 bbl., and shipments from the mills, 1,096,000 bbl., valued at $2,193,000, an average value per barrel of about $2.00. Corresponding figures for 1932, from final reports of the producers, follow: High-early-strength portland cement produced 1,287,586 bbl.; shipments, 1,105,191 bbl., valued at $1,915,215, an average value per barrel of $1.73.

Masonry cement, of the portland cement class, reported produced in 1933: Approximately 386,000 bbl.; shipments from mills, 395,000 bbl., valued at $535,000, an average value per barrel of about $1.35. Corresponding figures for 1932, from final reports of the producers, follow: Masonry cement produced, 433,332 bbl.; shipments 442,038 bbl., valued at $581,255, an average value per barrel of $1.31.

Miscellaneous special cements (including so-called "oil-well" and "high-silica" portland cements and cement manufactured under the trade name "super") produced in 1933: Approximately 807,000 bbl.; shipments, 754,000 bbl., valued at $1,314,000, an average value per barrel of about $1.74. Corresponding figures for 1932, from final reports of the producers, follow: Miscellaneous cement produced, 413,644 bbl.; shipments, 340,494 bbl., valued at $577,175, an average value per barrel of $1.70.

Accidents Fewer but Severe

THE bright spots in the 1933 safety picture for cement mills are a smaller total of accidents than ever before and a larger number of mills operating entirely free from mishaps.

In contrast are a very slight increase in accident frequency, a larger number of accidents involving disability and death than in 1932, more days lost time, and a severity rating almost 50 per cent higher than in the preceding year.

Tables in the August (1934) issue of the *Accident Prevention Magazine*, published by the Portland Cement Association, give the complete story of the industry's 1933 record.

Requirements for Refractory Cements

British Investigator Finds Each a Separate Problem Requiring Study—Explains Qualities Needed

By W. O. LAKE

REFRACTORY cement or lute is now regarded as an indispensable part of a furnace, and the old-fashioned recipe, consisting of a mixture of powdered clay and brickdust, moistened with a solution of salt and water, would be quite useless to meet present-day furnace conditions. Up to comparatively recent years the refractory cement in general use for furnaces was fireclay with the addition of ground firebrick, sand, borax, salt, and other ingredients having fluxing properties. As the manufacture of refractories advanced, particularly in regard to neutral firebrick, something more than this was necessary; especially as research revealed the fact that cemented firebrick joints eroded much more quickly than the bricks themselves.

Requirements for Refractory Cements

Further research led to the use of high-temperature cements now on the market; cements which form joints capable of outliving any of the fireclay-grog mixtures. The only objection to high-temperature cements is their initial cost. This is due to their basic materials having to be fused, or pre-shrunk to such an extent as to be stable under all conditions. Such material provides a matrix for refractory cements which can be adjusted by adding different fluxing agents, so providing a wide range of plasticity and fusion points. In this way, a refractory cement may be produced to suit a given set of conditions; and engineers and metallurgists are beginning to realize that such cements are now indispensable for furnace construction.

Qualities of Refractory Cements—Refractory cements of good quality should possess the following properties: (1) High refractory quality; (2) low shrinkage; (3) coefficient of expansion and contraction equal to the bricks with which they are to be used; (4) resistance to load under high temperature; (5) capability of resisting slag attack; (6) smooth working quality. Today it is not a matter of finding a cement to meet all conditions; the particular furnace conditions must be studied, and the cement made to meet those conditions. Most proprietary refractory cements and lutes fail because they have too high or too low a fusing point for the work they have to do. This is not intrinsically the fault of the cement, but of the employment of a cement unsuited to the particular case.

Working Conditions—Generally speaking, the conditions met with in a furnace do not demand the maximum refractory quality of either the brick or the cement; consequently, a cement which has a high fusion point may prove unsuitable because the furnace does not reach the temperature at which the bond functions. The temperature at the inside face of a furnace wall may be 1,425 deg. C., but this falls rapidly when farther away from this point. This fall in temperature may be about 90 deg. C. per inch of distance from the inner face, and as it requires approximately 1,260 deg. C. to form a bond when raw fireclay is used, it follows that the bond will only be formed for an inch or two back from the inside furnace face. Beyond that, the fireclay merely becomes friable. When it is desired that refractory bricks should be bonded throughout a special refractory cement must be used.

Shrinkage—The question of shrinkage is also of great importance. Raw fireclay may shrink to such an extent as to leave cracks ⅛ in. wide. The addition of calcined fireclay will partly overcome this; but if such a mixture is used, the furnace has to be very carefully constructed, and the joints made thin. It is always preferable to use a high-temperature cement, which will shrink less than a mixture of fireclay and grog.

Expansion and Contraction—The coefficient of expansion and contraction of a refractory cement must be approximately the same as the brick with which it is used. This statement, however, is subject to some qualification. It is found, for instance, that high silica-cement is equally suitable for either silica or fireclay brick, although the coefficient of expansion of silica bricks is much higher than that of fireclay bricks. However, the general rule stands, that cement and brick should approximately agree in their coefficient of expansion and contraction.

Resistance to Load under High Temperatures—The resistance of a cement under load at high temperatures may be of secondary importance where the joints are thin; but in practice, it is seldom possible to make thin joints everywhere, thick joints being unavoidable in parts. If the load is to be evenly distributed over the entire surface of the furnace, the cement as well as the brick should be capable of standing up to the load. Failure in this respect means that the bricks will move wherever there is shearing stress.

Slag Attack—As most furnace linings are subject to slag-attack the use of a fireclay grog mixture is inadvisable, as the furnace lining would speedily break down. Low porosity is a condition of resistance to slag erosion. Not only the bricks, but the cement also, should be of low porosity. Slag must never be allowed to penetrate beyond the surface of a furnace wall; hence, the cement must be such as will prevent slag entering in at the joints. A refractory cement of low porosity is therefore essential to safety. Open or porous joints also allow the penetration of gases and fumes. If the pressure outside the furnace is higher than within, such penetration will lower the furnace temperature. If the inside pressure is the higher, gases and fumes will pass through the porous joints, raising the temperature of the wall. These conditions result in chemical attack, causing spalling and other troubles in the brickwork.

Smooth Working Qualities — The necessity for thin joints has been stressed. The use of the trowel for making

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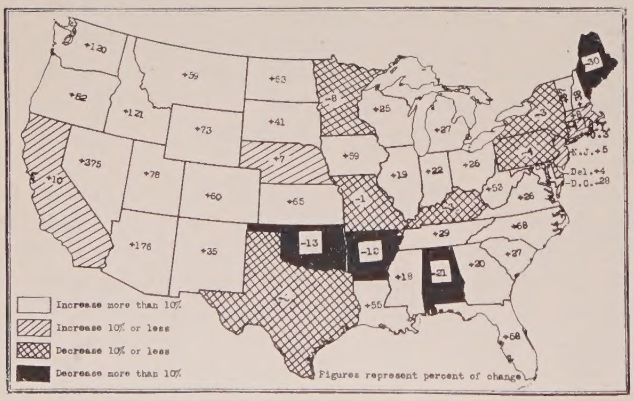
From January (1933) issue of *Sands, Clays and Minerals*, Chatteris, England.

joints is not to be recommended. If two firebricks be dipped into a slip composed of cement and water, and pressed together, the resulting joint will be found to be stronger than a joint made with cement spread with a trowel. In practice, however, dipping alone is not enough, as this method does not fill in every space, which is an essential condition of successful work. It is recommended that a combination of dipping and pouring be employed. This ensures that all the vertical, as well as the horizontall, joints will be filled, and will produce a wall that is almost perfectly homogeneous. Refractory cement should be mixed with water to the consistency of thick cream, so that it hangs well to the brick. Hot water sometimes gives better results than cold, in mixing refractory cements, as it ensures quicker working and greater plasticity. All faces of fire-brick should be dipped in a refractory cement slip before use. Walls and arches may be coated with refractory cement applied by a whitewash brush, the material being brushed on in two thin coats, which will form a more tenacious surface than a trowelled face. Such procedure applies both to new work and to repairs. When worn walls have to be recoated, the attempt to build up a thick coating in one operation is almost certain to result in failure. The repair should be carried out by applying thin coats in succession, and the application of frequent thin coatings will keep a furnace wall in good condition.

Cement Map of United States Is Less Favorable

THE cement map of the United States continues to be much more white than black, shipments for the 6-month period ending July 31 making a very favorable comparison with the corresponding period of 1933. The showing, however, is not quite so good as it was in similar 6-month periods ending May 31 and June 30.

From the map here illustrated it will be seen that for the 6-month period ending July 31, increased shipments (as compared with a year earlier) were experienced in 38 states, and decreases in 10 states. Comparisons follow:



Period considered	Number of states Showing decrease	Number of states Showing increase
6 months ending Jan. 31, 1934	34	14
6 months ending March 31, 1934	17	31
6 months ending June 30, 1934	7	41
6 months ending July 31, 1934	10	38

1933 Safety Competition

THE winners of the National Safety Competition of 1933, in which recognition was given to notable records attained during the calendar year 1933 by numerous mines and quarries, were announced on June 27, 1934, by Scott Turner, Director, United States Bureau of Mines, Department of the Interior, which sponsored the contest. Three hundred and thirty-two mines and quarries in 35 states participated in the competition, and outstanding accomplishments were achieved in the operation of mines and quarries without accidents or with quite low accident rates in 1933. The competing companies were divided into five classes. A replica of the bronze trophy, "Sentinels of Safety," donated by the Explosives Engineer magazine, was awarded to the winning company in each group.

In the group comprised of quarries and open-cut mines, the following-named operations were given honorable mention. All of these mines or quarries operated without a lost-time accident in 1933.

Cape Girardeau limestone quarry, Cape Girardeau, Mo., of the Marquette Cement Manufacturing Co.

Ruegg limestone quarry, Ruegg, Mo., of the Missouri Portland Cement Co.

No. 3 cement-rock quarry, Coplay, Pa., of the Coplay Cement Mfg. Co.

Nos. 5 & 6 limestone quarries, Martinsburg, W. Va., of the North American Cement Corp.

Ormrod cement-rock quarry, Ormrod, Pa., of the Lehigh Portland Cement Co.

No. 6 limestone and cement-rock quarry, Nazareth, Pa., of the Pennsylvania-Dixie Cement Corp.

West Conshohocken cement-rock quarry, West Conshohocken, Pa., of the Valley Forge Cement Co.

Mason City limestone and clay quarry, Mason City, Iowa, of the Lehigh Portland Cement Co.

Mitchell limestone quarry, Lehigh Lime Company, Lawrence County, Ind., of the Lehigh Portland Cement Co.

Speed limestone quarry, Speed, Ind., of the Louisville Cement Co.

Brooksville limestone and clay quarry, Brooksville, Fla., of the Florida Portland Cement Co.

San Vicente limestone quarry, Davenport, Calif., of the Santa Cruz Portland Cement Co.

Stockertown cement-stone quarry, Stockertown, Pa., of the Hercules Cement Corp.

Birmingham limestone quarry, Birmingham, Ala., of the Lehigh Portland Cement Co.

Richard City limestone quarry, Richard City, Tenn., of the Pennsylvania-Dixie Cement Corp.

Lime plant limestone quarry, Thomaston, Maine, of the Lawrence Portland Cement Co.

Greencastle limestone quarry, Greencastle, Ind., of the Lone Star Cement Co. Indiana, Inc.

Union Bridge limestone quarry, Union Bridge, Md., of the Lehigh Portland Cement Co.

Martins Creek No. 4 cement-rock quarry, Martins Creek, Pa., of the Alpha Portland Cement Co.

Catskill limestone quarry, Catskill, N. Y., of the Alpha Portland Cement Co.

Nazareth cement-rock quarry, Nazareth, Pa., of the Lone Star Cement Co., Pa.

Lone Star limestone quarry, Greenport, N. Y., of the Lone Star Cement Co., New York, Inc.

Fordwick limestone quarry, Fordwick, Va., of the Lehigh Portland Cement Co.

Fogelsville limestone quarry, Fogelsville, Pa., of the Lehigh Portland Cement Co.

Petoskey limestone quarry, Petoskey, Mich., of the Petoskey Portland Cement Co.

The National Safety Competition of 1933 revealed a larger number of accident-free mines and quarries in proportion to the total number enrolled than in any previous year, Mr. Turner commented. The contest also revealed a greater number of plants whose accident rates were remarkably low.